Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
1
Ag84Mrr

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
DEC 1 - 1953
CURRENT SERIAL RECORDS

TOMATO

REPACKING METHODS AND EQUIPMENT

U.S. Department of Agriculture • Agricultural Marketing Service
Transportation and Facilities Research Division
Marketing Research Report No. 597

Preface

The purpose of this research is to measure the relative efficiency of current methods and equipment used in receiving and handling mature green tomatoes in terminal market areas, and in preparing the tomatoes for market. The project is part of a broad research program conducted by the Agricultural Marketing Service, U.S. Department of Agriculture, to improve marketing efficiency and hold down marketing costs. This project was conducted under the supervision of Robert K. Bogardus, industrial engineer, Handling and Facilities Research Branch, Transportation and Facilities Research Division, AMS.

The following companies made their facilities available for detailed studies of tomato sorting, packing, and handling operations:

Baltimore Tomato Co., Inc., Baltimore, Md.; Thomas Colace Co., Philadelphia, Pa.; Dixon and Tom-A-Toe, Inc., Indianapolis, Ind.,; G. Fava Fruit Co., Baltimore, Md.; Michigan Repacking and Produce Co., Detroit, Mich.; Fort Pitt Tomato and Produce Co., Pittsburgh, Pa.; Safeway Pre-Pakt and Produce Dept., Washington, D.C.; Tomato Distributing Corp., San Antonio, Tex.; and Twin Packing Co., Philadelphia, Pa.

Some previous marketing research reports on sorting, packing, and handling fruits and vegetables, issued by the United States Department of Agriculture, are:

Methods, Equipment, and Facilities for Receiving, Ripening, and Packing Bananas. MRR No. 92, June 1955. For sale by the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402; price 65 cents.

Apple Sorting Methods and Equipment. MRR No. 230, August 1958. For sale by the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402; price 20 cents.

Loading Out Fruits and Vegetables in Wholesale Warehouses. MRR No. 282, March 1959. Out of print; available at principal libraries.

Wholesale Fruit and Vegetable Warehouses; Layouts and Designs. MRR No. 467, August 1961. Available from the Office of Information, U.S. Department of Agriculture, Washington, D.C., 20250.

Receiving Fruits and Vegetables in Wholesale Warehouses. MRR No. 478, October 1961. Available from same source as MRR No. 467, above.

Contents

	Page
Summary	2
Background	3
Sorting methods and equipment	4
Four-lane roller table	4
Three-lane roller table	5
Belt table with packing bins	8
Three-lane roller table with packing bins	9
Belt table	11
Comparison of five tomato sorting systems	13
Packing methods and equipment	14
Tray-packing	14
Place-packing	23
Handling operations and equipment	26
Types of handling equipment	26
Handling operations and equipment—Con.	
Handling operations	27
Costs of handling operations	29
Assembling shipping containers	29
Bruise damage to tomatoes	31
Repacking systems composed of the most efficient methods studied	31
Equipment requirements	31
Labor requirements	32
Labor and equipment costs	35
Appendix	39
Research methods and techniques	39
Labor costs	39
Fatigue allowances	39
Productive labor data	40
Equipment requirements and costs	50

5a

Washington, D.C. October 1963

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 40 cents

Summary

Most tomato repackers can reduce costs for sorting, packing, and handling tomatoes by 10 to 40 percent by adopting more efficient methods and equipment.

Evaluation of five systems of sorting tomatoes for quality and degree of ripeness showed the most efficient sorting was done at a four-lane roller table. In this study, labor and equipment costs, with a 10-man crew, for the initial sorting of 1,000 pounds of tomatoes were $1.28. Costs of the other systems ranged from $1.88 to $3.04. Total costs were $1.76 per 1,000 pounds for a second sorting at the four-lane roller table, and ranged from $2.39 to $3.63 for the other systems.

Tray-packing, including sizing of the tomatoes and a final sorting for quality and degree of ripeness, was most efficiently done when the packing, sizing, and sorting were performed by separate crews. Equipment used was a single-lane roller table, a sorting belt, and divided packing bins. Labor and equipment costs were $9.99 per 1,000 pounds, compared to costs ranging from $12.17 to $16.62 for five other systems studied.

The least costly method of place-packing was the loose pack—placing tomatoes in cartons without using individual paper wrappers or cups.

Labor and equipment costs for handling boxes of fruit were lower for the electric pallet transporter than for the two-wheel clamp truck and the manual low-lift platform truck with dead skids. Handling operations included receiving and loading out, and all movement of boxes of fruit within the plant.

Labor and equipment requirements for efficient sorting, packing, and handling of tomatoes were developed in this study for plants receiving annual volumes of 1½, 3, 5, and 10 million pounds of tomatoes. For an operating season of thirty 40-hour weeks, the labor required for the 4 annual volumes is 9, 16, 25, and 48 men. Labor and equipment costs per 1,000 pounds of tomatoes, using the most efficient methods tested, are estimated to be:

Annual volume received	*Costs*
1½ million pounds	$14.80
3 million pounds	13.22
5 million pounds	12.05
10 million pounds	11.59

Packers can better maintain tomato quality and reduce spoilage losses by adopting practices that reduce bruise damage to the fruit caused by rough or excessive handling.

Tomato Repacking Methods and Equipment

By Charles H. Meyer, *agricultural economist, Transportation and Facilities Research Division, Agricultural Marketing Service**

Background

Repacking tomatoes at terminal markets in packages for consumers—trays or tubes holding three or four tomatoes each—presents many operating problems. Tomatoes are received as mature green fruit. They must be ripened, sorted for quality and degree of ripeness, and sized, before they are packed. Ripening is not uniform, and much of the fruit is sorted and handled to and from ripening rooms several times before it is ready to pack.

The many operations involved make operating costs high; but these costs are higher than necessary in many terminal markets because inefficient methods and equipment are used. These methods and equipment also cause serious damage to the fruit because it is roughly handled.

A study was made (1) to analyze and compare methods and equipment used to perform each operation involved in repacking tomatoes at terminal markets, and (2) to devise a workable tomato repacking system consisting of the most efficient method and equipment for each operation. Labor and equipment requirements for this system are developed for plants receiving annual volumes of 1½, 3, 5, and 10 million pounds of tomatoes. Suggestions are made for reducing bruise damage to the fruit.

The study was made in nine tomato repacking plants, and it included different volumes of production. Each step was observed, from the time the fruit was received through the loading of packed fruit into trucks for delivery to retailers. Time-study techniques were used to obtain man- and machine-hour requirements. Details of the techniques are presented in the appendix.

Total labor and equipment costs were computed for each operation or group of operations. Equipment costs were computed on the basis of annual hours of use required for handling a volume of 3,000,000 pounds. Labor cost was computed at $2.00 per hour, including fringe benefits such as workmen's compensation, paid vacations, social security, and unemployment compensation.

Operations at terminal markets, as discussed in this report, are divided into four groups: (1) Sorting for quality and degree of ripeness; (2) packing, including sizing and a final sorting for quality and degree of ripeness; (3) handling, which consists of receiving crates of unripened fruit, all movements of boxes of fruit to and from ripening rooms and sorting and packing lines, and loading packed fruit onto delivery trucks; and (4) assembling shipping containers.

It is assumed that 85 percent of the tomatoes packed are placed in trays holding three or four tomatoes each, and 15 percent are place-packed in containers holding 10, 20, or 28 pounds of fruit. Tomatoes packed in trays are referred to as size 3 or size 4; tomatoes too large for trays are referred to as large or place-pack size.

*Mr. Meyer has transferred from AMS to the Farmer Cooperative Service of the Department of Agriculture.

Sorting Methods and Equipment

Mature green tomatoes are usually sorted for quality and degree of ripeness within 5 days after receipt at the terminal market. The fruit is usually sorted into: "Culls," which have a market value but are unsuitable for packaging; "rejects," which are unfit for human consumption; "greens," which show no red or yellow; "breakers," which show a break in color up to 25 percent red or yellow; "turns," which show from 25 to 50 percent red or yellow; "pinks," which show more than 50 percent but less than full color; and "ripes," which show full color over the entire surface. The color definitions are based on commercial practices followed in many tomato repacking plants; these definitions differ slightly from the official color classification.[1]

The sorted fruit is placed in lugs, and green fruit, breakers, and turns (the majority of the fruit) are returned to ripening rooms and sorted again 5 to 10 days later. Pinks and ripes from both the initial and second sortings may be packed immediately or may be held for a while before they are moved to the packing line.

Greens, breakers, and turns that are returned to the ripening rooms after the second sorting usually are later moved directly to the packing line, although in some plants, this fruit may be sorted a third time before going to the packing line. Only first and second sortings are analyzed in this report.

Tomatoes are sorted on roller or belt tables, with various attachments or equipment. On roller tables, the fruit is alined in rows between closely spaced rollers, and it is rotated as it moves down the table (fig. 1). Roller tables are usually divided lengthwise into three or four lanes. On belt tables, the fruit is simply conveyed down the table; the tomatoes are not organized in rows or lanes nor are they rotated. Most roller tables are about 16 feet long, and range from 40 to 70 inches wide. The commonly used belt sorting table is 24 inches wide and 40 to 60 feet long.

Five sorting tables, variously equipped, and two methods of sorting were studied. The sorting tables are described in the sections following; they are identified here as: (1) A four-lane roller table; (2) a three-lane roller table; (3) a belt table; (4) a belt table with packing bins; and (5) a three-lane roller table with packing bins. The last two tables are intended for use primarily with packing lines, rather than for initial and second sortings; fruit sorted at these tables is sized as well as sorted for quality and degree of ripeness.

The two methods of sorting were: (1) Each worker was assigned specific colors to sort for; and (2) each worker sorted for all colors.

In addition to methods and equipment used, the quality of the fruit itself is an important factor in speed of sorting. To maintain quality, tomatoes should be sorted soon after arrival at the plant.

BN-17242

FIGURE 1.—Tomatoes are rotated and alined in rows as they move down this roller sorting table.

The average proportions of culls, rejects, and sound fruit of the various color gradations, as observed in all sorting operations in this study, were as follows:

For a first sorting: 60 percent greens, 12 percent breakers, 10 percent turns, 8 percent pinks, 5 percent ripes, 2 percent culls, and 3 percent rejects.

For a second sorting: 30 percent greens, 25 percent breakers, 17 percent turns, 10 percent pinks, 10 percent ripes, 5 percent culls, and 3 percent rejects.

Analyses of methods and equipment for first and second sortings are based on man-hour requirements and costs per 1,000 pounds of tomatoes sorted, in the proportions listed.

Labor required for dumping 1,000 pounds of tomatoes at the sorting table for a first sorting is based on use of 60-pound wirebound crates, and, for a second sorting, wooden lugs holding 20 pounds of loose fruit (figs. 2 and 3). At the time the study was made, the 60-pound wirebound crate was widely used for shipping tomatoes from producing areas to markets. Most terminal-market tomato repackers use the standard 30-pound-capacity wooden lug for ripening and in-plant handlings of fruit. Net weight of fruit handled in lugs ranged from about 18 to 24 pounds. The desirable amount for best ripening of fruit and handling with a minimum of bruising was judged to be 20 pounds per lug.

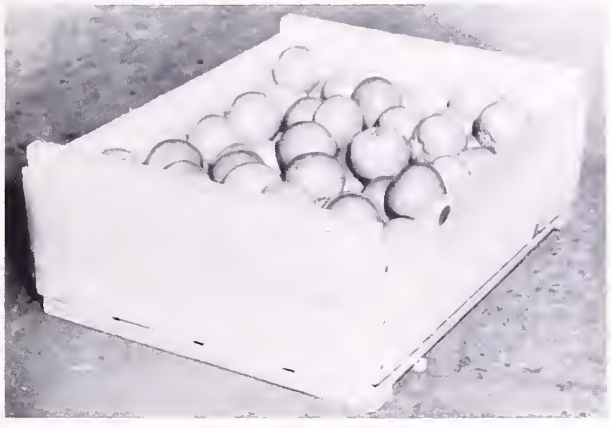
Four-Lane Roller Table

The four-lane roller table commonly used for sorting tomatoes is about 16 feet long and 5 to 6 feet wide. The table is usually equipped with a spray-type washer, chutes for transferring fruit

[1] Official U.S. Standards for Grades of Fresh Tomatoes, as amended on October 15, 1961.

BN-17240

FIGURE 2.—A worker unfastening wires on a 60-pound wirebound crate of tomatoes.



BN-17255

FIGURE 3.—Lug containing about 20 pounds of loose tomatoes.

from the outside to the inside lanes, and two runoff (moving) belts. The belts are centered over the table, one above the other. A collection bin is at the end of each lane. The bottom of each bin is slightly sloped and the end of the bin is a trapdoor, operated by a foot treadle. When the trapdoor is opened, the tomatoes roll out and are collected in lugs. Fruit is dumped at the head of the table, moved through the washer, and conveyed down the table in the two outside lanes.

Turns and breakers were usually combined and sorted into one inside lane, and ripes and pinks combined into the other. Culls and rejects were sorted onto the two runoff belts. Green fruit (the predominant color) remained in the two outside lanes. This arrangement minimized handling.

Studies were made of this table for two crew sizes and two speeds of movement of the tomatoes (the "speed of translation"). A 10-man crew was used when the forward speed was set at 36 feet per minute, and a 5-man crew for a speed of 30 feet per minute. The same translation speeds were used for first and second sortings.

The 10-man crew for an initial sorting consisted of two workers opening and dumping crates (one for each outside lane), four sorters (two on each side of the table), and four workers to break out and place empty lugs below the collection bins, fill the lugs, and place them in unit loads (fig. 4). Each sorter sorted for all colors and for quality. A 10-man crew was used also for second sortings of loose fruit handled in lugs.

Table 1 shows labor requirements for first and second sortings for 1,000 pounds of tomatoes on a 4-lane roller table operated at a speed of 36 feet per minute with a 10-man crew. Only 0.600 man-hour was required for the first sorting. The second sorting took 0.825 man-hour, because more fruit showed color and had to be moved by the sorters from outer to inner lanes. Unproductive time was less than 2 percent of the total required labor in both sortings. Production rates for first and second sortings on the 4-lane roller table with the 10-man crew were the best of those for the 5 sorting tables studied.

Total labor requirements for sorting on the four-lane roller table, using a five-man crew and a roller translation speed of 30 feet per minute, are shown in table 2. The crew consisted of a dumper, two sorters (one on each side of the table), and two workers to tend the four collection bins. The relatively small unproductive time, charged to the dumper, was about the same for both sortings. At a roller translation speed of 30 feet per minute, the sorters and two workers breaking out empty lugs, filling them with fruit run off in lanes, and placing filled lugs in unit loads were fully occupied for most lots of fruit sorted.

Three-Lane Roller Table

This three-lane roller table is 16 feet long; the center lane is 20 inches wide and the two outside lanes are 10 inches wide. Runoff chutes are at the end of each lane. A washer is at the head of the table, and a short section of roller conveyor is placed at a right angle to the runoff chutes at the end of the table. Movable stands for lugs are located at sorting stations on both sides of the table. A 6-inch belt conveyor, located over the center of the table, is used during second sortings to transfer empty lugs from the head to the end of the table. Fruit is dumped into the center lane. The table is operated at a speed of 30 feet per minute.

The three predominant colors were run off in the three lanes. Since fruit for a first sorting was assumed to be 60 percent greens, 12 percent breakers, 10 percent turns, 8 percent pinks, and 5 percent ripes, green fruit was run off in the center lane and breakers and turns were sorted into the

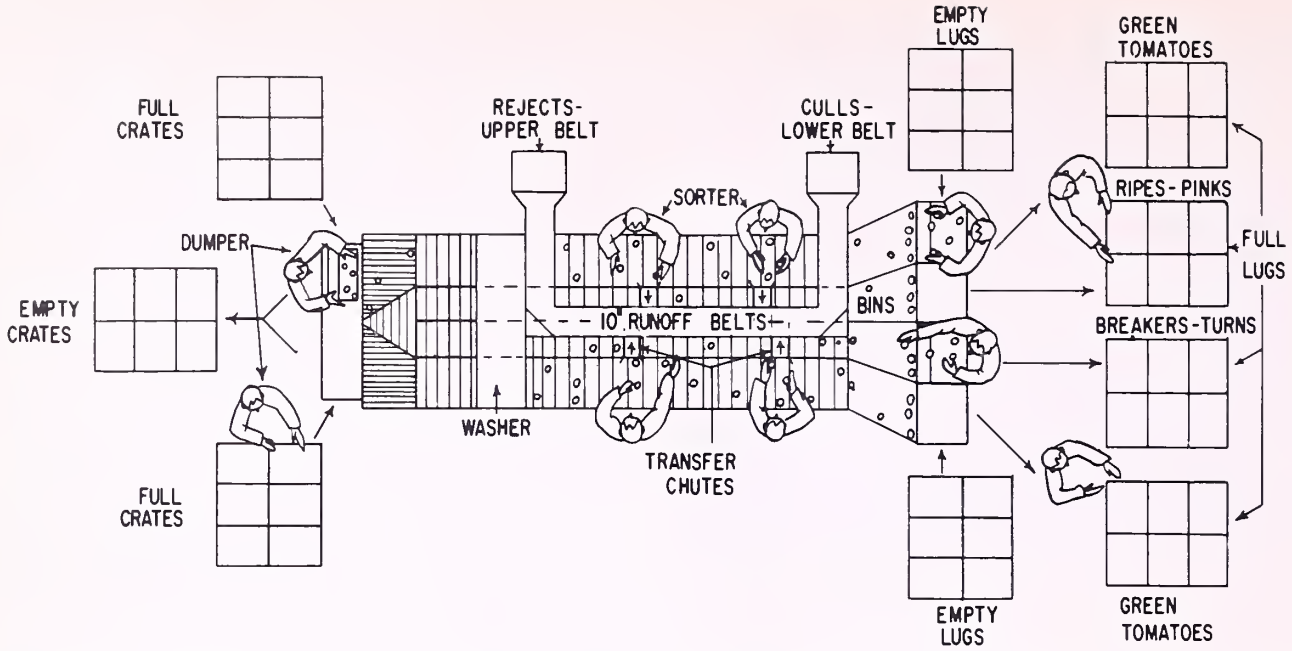


FIGURE 4.—Four-lane roller table with runoff belts. Four sorters can inspect and sort a large volume of tomatoes when the table is operated at a speed of 36 feet per minute.

TABLE 1.—*Labor requirements per 1,000 pounds for first and second sortings of tomatoes by a 10-man crew on a 4-lane roller table operated at 36 feet per minute* [1]

Time item	First sorting [2]		Second sorting [3]	
	Crew [4]	Labor required	Crew [5]	Labor required
Productive labor:	*Number*	*Man-hours*	*Number*	*Man-hours*
Open and dump	2	0. 120	2	0. 165
Sort	4	. 230	4	. 305
Catch runoff in lugs	4	[6]. 240	4	[7]. 330
Total productive labor		. 590		. 800
Unproductive labor:				
Sorters wait for dumpers	4	. 010	4	. 025
Total labor	10	. 600	10	. 825
Elapsed hours		. 0600		. 0825

[1] Fruit was carried from dumper in outside lanes. Greens were run off into lugs in outside lanes; turns (including breakers) and ripes (including pinks) were sorted into inside lanes and run off into lugs; and culls and rejects were sorted onto belts.

[2] First sorting for fruit handled in 60-pound wirebound crates consisted of 600 pounds of greens, 220 pounds of breakers and turns, 130 pounds of pinks and ripes, 30 pounds of rejects, and 20 pounds of culls.

[3] Second sorting for fruit handled in 20-pound lugs consisted of 300 pounds of greens, 420 pounds of breakers and turns, 200 pounds of pinks and ripes, 50 pounds of culls, and 30 pounds of rejects.

[4] Crew organization: 2 workers transport, open, and dump 60-pound wirebound crates and set aside empty crates; 4 workers sort (2 on either side of table); and 4 workers, working independently, break out empty lugs, place under runoff chutes, fill, and transport to unit loads.

[5] Crew organization: 2 workers dump 20-pound lugs and set aside empty lugs; 4 workers sort (2 on either side of table); and 4 workers, working independently, break out empty lugs, place under runoff chutes, fill, and transport to unit loads.

[6] Based on the elapsed time required for the crew (0.0600×4=0.240 man-hour).

[7] Based on the elapsed time required for the crew (0.0825×4=0.330 man-hour).

TABLE 2.—*Labor requirements per 1,000 pounds for first and second sortings of tomatoes by a 5-man crew on a 4-lane roller table operated at 30 feet per minute* [1]

Time item	First sorting [2]		Second sorting [3]	
	Crew [4]	Labor required	Crew [5]	Labor required
Productive labor:	*Number*	*Man-hours*	*Number*	*Man-hours*
Open and dump	1	0.120	1	0.165
Sort	2	.354	2	.450
Catch runoff in lugs	2	[6] .354	2	[7] .450
Total productive labor		.828		1.065
Unproductive labor:				
Dumper waits for sorters	1	.057	1	.060
Total labor	5	.885	5	1.125
Elapsed hours		.1770		.2250

[1] Fruit was carried from dumper in outside lanes. Greens were run off into lugs in outside lanes; turns (including breakers) and ripes (including pinks) were sorted into inside lanes and run off into lugs; culls were sorted onto one belt and run off into lug; and culls and rejects were sorted onto belts.

[2] First sorting for fruit handled in 60-pound wirebound crates consisted of 600 pounds of greens, 220 pounds of breakers and turns, 130 pounds of pinks and ripes, 30 pounds of rejects, and 20 pounds of culls.

[3] Second sorting for fruit handled in 20-pound lugs consisted of 300 pounds of greens, 420 pounds of breakers and turns, 200 pounds of pinks and ripes, 50 pounds of culls, and 30 pounds of rejects.

[4] Crew organization: One worker transports, opens and dumps 60-pound wirebound crates and sets aside empty crates; 2 workers sort (1 on each side of table); and 2 workers, working independently, break out empty lugs, place them under runoff chutes, fill, and transport to unit loads.

[5] Crew organization: One worker dumps 20-pound lugs and sets aside empty lugs; 2 workers sort (1 on each side of table); and 2 workers, working independently, break out empty lugs, place them under runoff chutes, fill, and transport to unit loads.

[6] Based on the elapsed time required for the crew (0.1770×2=0.354 man-hour).

[7] Based on the elapsed time required for the crew (0.2250×2=0.450 man-hour).

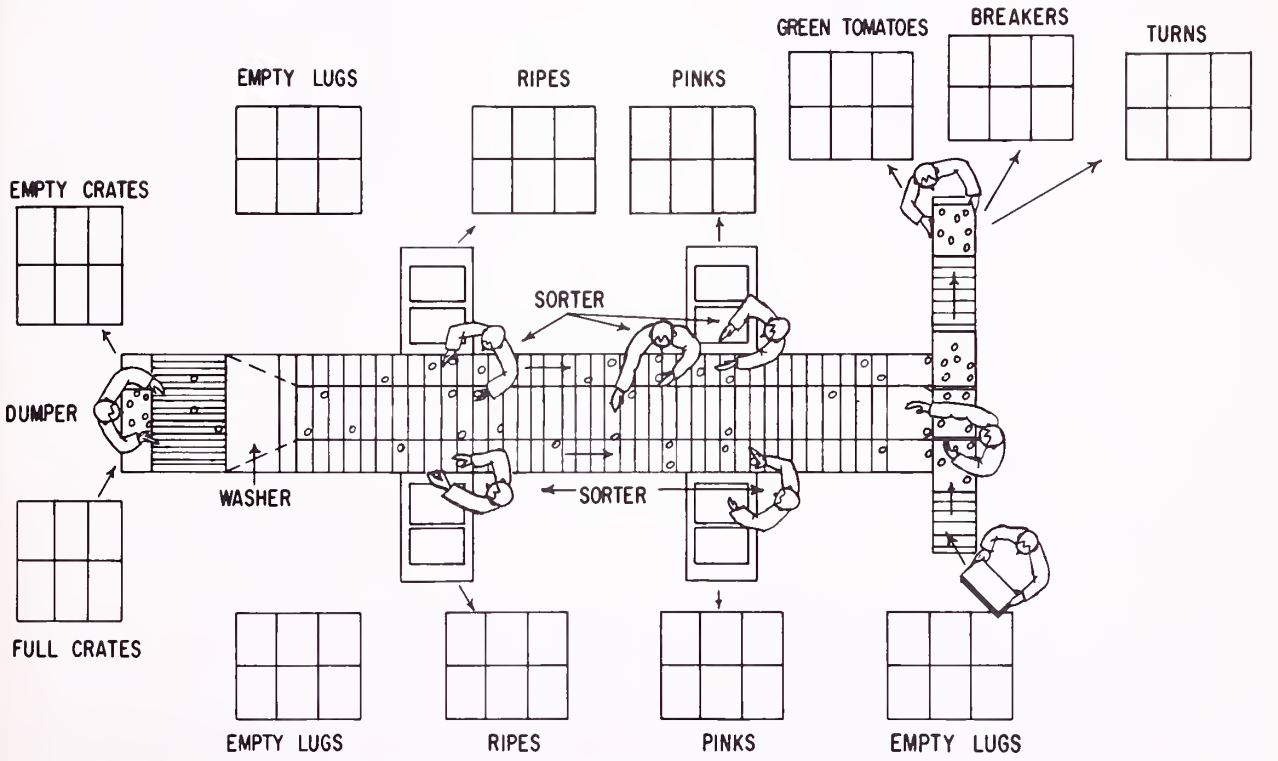


FIGURE 5.—A nine-man crew sorted tomatoes on this three-lane roller table. Rejects and culls were put in pails under the table.

outside lanes and run off. Ripe and pink tomatoes were sorted into lugs on the movable stands. Rejects and culls were tossed into pails.

The crew for a first sorting consisted of nine workers (fig. 5). One worker opened and dumped crates. Two of five sorters—those nearest the dumper—sorted ripe and pink fruit into lugs, and rejects and culls into pails, while the other three sorted turning and breaking fruit into the two outside lanes and lifted any rejects, culls, ripe, or pink fruit missed by the first two sorters. One worker broke out and transported empty lugs to stands at sorting stations on both sides of the table and to the roller conveyor at the end of the table. This worker also transported full lugs of ripe and pink fruit from stands to unit loads. At the runoff chutes, one worker filled lugs, levelled the fruit, and pushed the lugs forward on the roller conveyor to another worker, who placed them in unit loads.

Labor requirements for a second sorting are based on the use of an eight-man crew. The worker breaking out empty lugs at the end of the table was not required for second sortings. The lugs emptied by the dumper were placed on the belt conveyor above the table for transport to the other end of the table. The worker at this end removed the lugs from the conveyor and placed them under the runoff chutes. The worker dropped from the crew was reassigned to other jobs in the plant, such as receiving, loading packed fruit in delivery trucks, or assembling containers.

Table 3 shows total labor requirements per 1,000 pounds of tomatoes for an initial sorting by a nine-man crew and a second sorting by an eight-man crew. In the initial sorting, wait time of the five sorters accounted for over half of the total unproductive time. The five sorters and three workers catching runoff at the end of the table and transporting lugs to and from sorting stations were idle for 0.120 man-hour per 1,000 pounds. The production rate of the three-lane roller table, when operated at 30 feet per minute with the nine-man crew, was about 8,300 pounds per hour. In the second sorting, 5 percent, or 0.061 man-hour, was unproductive. The production rate for this crew for a second sorting was about 7,000 pounds per hour.

Belt Table With Packing Bins

This sorting belt was 60 feet long and 24 inches wide. It was equipped with a dump chute, two packing bins along one side, and a roller conveyor at the end, at a right angle to the belt. The belt was operated at a constant speed of 32 feet per minute.

At this table, fruit was sorted by size as well as by color and quality. A seven-man crew was used for an initial sorting. The layout of equipment and work stations for each of the seven workers used with this system is shown in figure 6. One

TABLE 3.—*Labor requirements per 1,000 pounds for first and second sortings of tomatoes by specified crews on a 3-lane roller table operated at 30 feet per minute* [1]

Time item	First sorting [2]		Second sorting [3]	
	Crew [4]	Labor required	Crew [5]	Labor required
Productive labor:	*Number*	*Man-hours*	*Number*	*Man-hours*
Open and dump	1	0. 120	1	0. 100
Sort	5	. 528	5	. 710
Catch runoff in lugs, transport lugs to sorters	3	. 312	2	. 265
Total productive labor		. 960		1. 075
Unproductive labor:				
Dumper waits for sorters			1	. 042
Sorters wait for dumper	5	. 072		
Wait for lugs to fill	3	. 048	2	. 019
Total unproductive labor		. 120		. 061
Total labor	9	1. 080	8	1. 136
Elapsed hours		. 1200		. 1420

[1] Fruit was carried from dumper in center lane. Greens were run off into lugs in center lane; breakers were sorted into one outside lane and turns into the other, and run off into lugs; ripes and pinks were sorted into separate lugs; and culls and rejects were sorted into pails.

[2] First sorting for fruit handled in 60-pound wirebound crates consisted of 600 pounds of greens, 120 pounds of breakers, 100 pounds of turns, 80 pounds of pinks, 50 pounds of ripes, 50 pounds of rejects and culls.

[3] Second sorting for fruit handled in 20-pound lugs consisted of 300 pounds of greens, 250 pounds of breakers, 170 pounds of turns, 100 pounds of pinks, 100 pounds of ripes, and 80 pounds of culls and rejects.

[4] Crew organization: One worker transports, opens, and dumps 60-pound wirebound crates and sets aside empty crates; 5 workers sort (3 on one side of table and 2 on the other); and 3 workers break out empty lugs for sorters and transport full lugs from sorting stations, break out empty lugs at runoff station (1 worker), fill (1 worker), and transport full lugs to unit loads (1 worker).

[5] Crew organization: One worker dumps 20-pound lugs and places empty lugs on 6-inch belt conveyor above sorting table; 5 workers sort (3 on one side of table and 2 on the other); and 2 workers break out and transport empty lugs to, and full lugs from, sorting stations, and transport full lugs from runoff chutes to unit loads (1 worker), and remove empty lugs from 6-inch belt conveyor, place under runoff chutes, and fill lugs with fruit run off at end of table (1 worker).

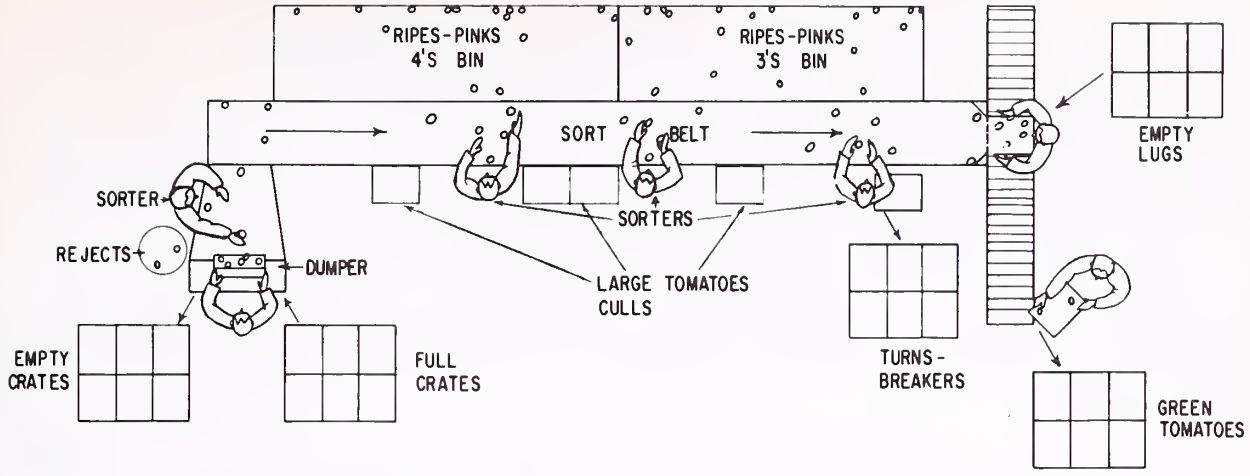


FIGURE 6.—Sorting tomatoes at a belt table with packing bins. This equipment is used primarily to inspect and sort ripened fruit. In some plants, however, it is used for initial sortings of mature-green fruit.

worker opened, dumped, closed, and set aside 60-pound wirebound crates. Four sorters were used. One sorter, stationed at the dump chute, removed rejects and regulated the flow of fruit onto the sorting belt. The first worker stationed beside the belt sorted ripe and pink tray fruit of size 4 into the first bin. The next worker sorted ripe and pink 3-size tray fruit into the other bin, and the fourth sorter, stationed near the end of the belt, removed turning and breaking fruit and placed it in lugs. All three sorters stationed beside the belt sorted culls and tomatoes of place-pack size into lugs. Green fruit was run off the end of the belt. Two workers handled the runoff of green fruit; one broke out and placed empty lugs on the roller conveyor, pushed them forward to the other worker catching runoff, and transported empty lugs to, and full lugs from, sorting stations.

A six-man crew was used for second sortings.

TABLE 4.—*Labor requirements per 1,000 pounds for first and second sortings of tomatoes by color and size by specified crews using a belt table and packing bins (speed of belt, 32 feet per minute)* [1]

Time item	First sorting [2]		Second sorting [3]	
	Crew [4]	Labor required	Crew [5]	Labor required
Productive labor:	*Number*	*Man-hours*	*Number*	*Man-hours*
Open and dump	1	0. 120	1	0. 165
Sort	4	. 609	3	. 670
Transport lugs to sorters	1	. 148	1	. 110
Catch runoff in lugs	1	[6] . 152	1	[6] . 223
Total productive labor		1. 029		1. 168
Unproductive labor:				
Dumper waits for sorters	1	. 032	1	. 058
Wait for full lugs	1	. 004	1	. 113
Total unproductive labor		. 036		. 171
Total labor	7	1. 065	6	1. 339
Elapsed hours		0. 1522		0. 2232

[1] Green fruit was run off end of belt into lugs, turns (including breakers) and culls were sorted into separate lugs, pinks and ripes were sorted into 2 packing bins, and rejects were sorted into pails or steel drums.

[2] First sorting of fruit handled in 60-pound wirebound crates consisted of 600 pounds of greens, 220 pounds of breakers and turns, 130 pounds of pinks and ripes, 30 pounds of rejects, and 20 pounds of culls.

[3] Second sorting of fruit handled in 20-pound lugs consisted of 300 pounds of greens, 420 pounds of breakers and turns, 200 pounds of pinks and ripes, 50 pounds of culls, and 30 pounds of rejects.

[4] Crew organization: One worker transports, opens, and dumps 60-pound wirebound crates and sets aside empty crates; 4 workers sort (1 worker sorts out rejects at dumper, 2 sort fruit ripe enough for packing into 2 bins, and culls into lugs, and 1 worker sorts breakers and turns into lugs); 1 worker breaks out empty lugs for sorters and for fruit run off belt, and transports full lugs from sorting stations and runoff station to unit loads; and 1 worker fills lugs with greens run off end of belt.

[5] Crew organization: One worker dumps 20-pound lugs and sets aside empty lugs; 3 workers sort (1 worker sorts out rejects at dumper, and 2 sort fruit ripe enough for packing into 2 bins, and culls into lugs); 1 worker breaks out empty lugs for sorters and for fruit run off belt, and transports full lugs from sorting stations and runoff station to unit loads; and 1 worker fills lugs with greens run off end of belt.

[6] Based on the elapsed time required for the crew.

683959 O—63——2

BN-17247

FIGURE 7.—Mechanical triangular-shaped sweep used to shunt tomatoes from belt conveyors into packing bins at the sides of the belts.

In this sorting, fruit showing not more than 50 percent red color (turns and breakers) was run off the end of the belt along with green fruit. This freed the fourth sorter for other work, such as assembling tray master containers, filling trays, or place-packing in cartons.

Table 4 shows labor requirements per 1,000 pounds for first and second sortings of tomatoes by this method. Unproductive time in the initial sorting amounted to 3 percent of the total required labor. In the second sorting, the worker breaking out empty lugs at the end of the belt and transporting full lugs to unit loads was idle for 0.113 man-hour.

Three-Lane Roller Table With Packing Bins

This three-lane roller table is equipped with a washer and two runoff belts, one above the other, centered over the table. A short section of belt conveyor is at the end of the lanes, at a right angle to the table. Beyond this are two 24-inch belt conveyors, equipped with a mechanical sweep (fig. 7) to shunt fruit into packing bins on the outer side of each belt.

In this operation, the two outer lanes were connected to the 24-inch belt conveyors, and the center lane was connected to the belt running at a right angle to the conveyor. The table was operated at the relatively slow translation speed of 16 feet per minute. Fruit was sorted for color, quality, and size.

The tomatoes were dumped into the outside lanes. Green fruit (including breakers and turns) was transferred to the center lane and run off onto the right-angle conveyor, where it was collected in lugs. Tray-size fruit, ripe enough for packing, was sorted into the outer lanes (3's in one lane and 4's in the other). At the end of the table, this fruit moved onto the belt conveyors and then into the packing bins. Rejects were sorted into pails. The two runoff belts over the table were used only for culls and large (place-pack size) fruit, although only a few lots of tomatoes contained a large proportion of fruit of this size.

Figure 8 shows a seven-man crew at their work stations and the layout of equipment for an initial sorting.

The crew was made up of: A worker to open and dump wirebound crates; four workers to sort for color, size, and quality (two on each side of the table); and two workers to attend runoff chutes. Each sorter inspected the fruit for quality, and sorted for all colors and sizes. For second sortings, one sorter was reassigned to other work in the plant and the remaining three sorters were all placed on one side of the table. One sorter was stationed near the dumper, to remove fruit unfit

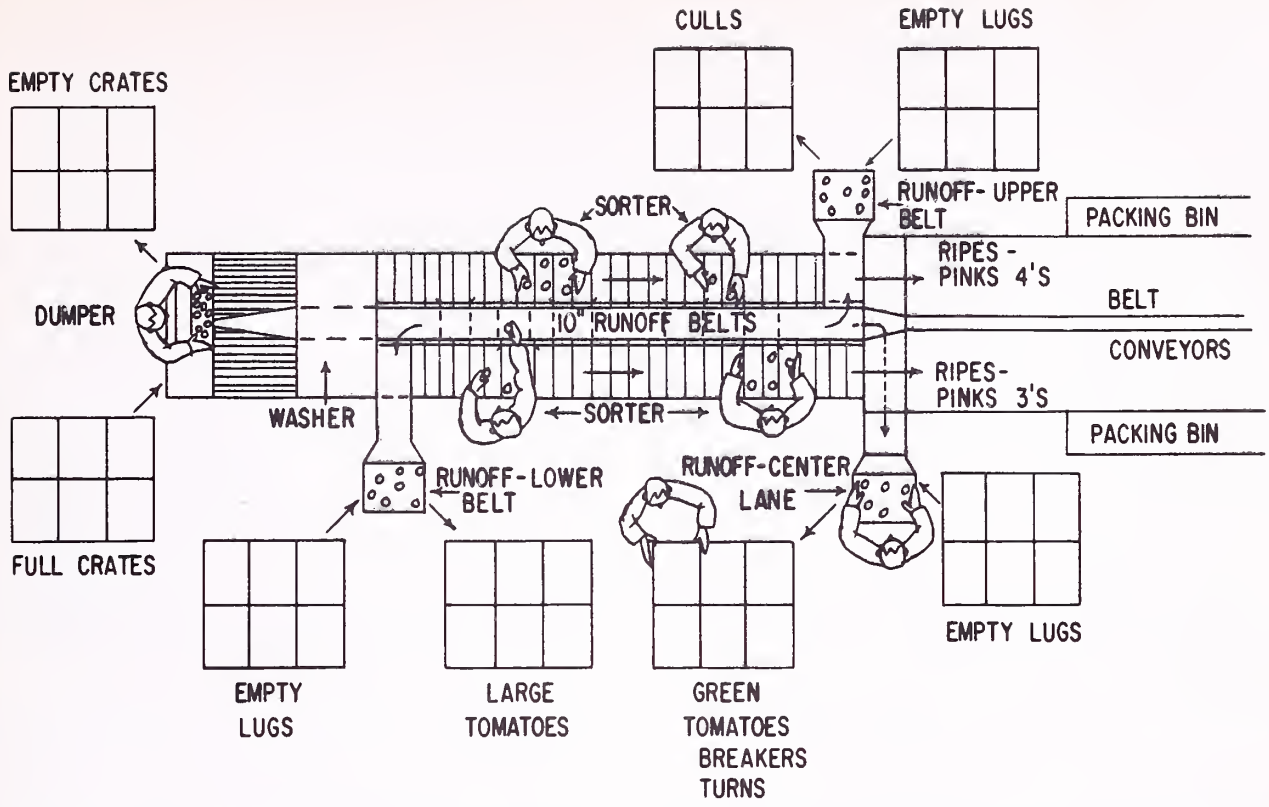


FIGURE 8.—Sorting tomatoes on a three-lane roller table. Fruit ripe enough to pack in trays was run off in outside lanes onto belt conveyors and shunted into packing bins by diagonal sweeps. Rejects were placed in pails under the table.

for human consumption. The other two workers sorted for color and size, and for any rejects missed by the first sorter. A dumper and two workers to catch fruit runoff from the center lane were used in addition to the three sorters for a second sorting of fruit.

Labor requirements for first and second sortings of tomatoes on the three-lane roller table with packing bins are shown in table 5. Total labor requirements for second sortings on this table, using a six-man crew, were about the same as those for the seven-man crew.

The efficiency of this table for an initial sorting of fruit containing a high percentage of green tomatoes could be substantially increased by: (1) Increasing the translation speed of the table from 16 to about 30 feet per minute; (2) running green fruit off in the outside lanes instead of the center lane; (3) sorting 3's onto one runoff belt and 4's onto the other; and (4) sorting culls and large fruit into lugs at both sides of the table.

The green fruit would still be dropped onto the conveyor running at a right angle to the table, and be collected in lugs. (The table is so constructed that fruit in the outside lanes may either be run off on the conveyor belts and into the packing bins or dropped onto the right-angled conveyor.)

This method would eliminate a great deal of the lifting of fruit required by the present method, in which green fruit is moved from the outside lanes to the center lane. The amount of ripe tray-size fruit in an initial sorting is relatively small; this fruit could be collected in lugs from the runoff belts, and manually transported to the packing bins. These changes would substantially reduce the man-hour requirements for a seven-man crew to sort 1,000 pounds of tomatoes.

Belt Table

The arrangement of equipment and crew for an initial sorting at the belt table is shown in figure 9. The sorting belt is 24 inches wide and 40 feet long. The dump chute at the head of the table is followed by a 5-foot section of powered roller conveyor, used to elevate the fruit and distribute it evenly on the sorting belt. A short section of roller conveyor is at a right angle to the end of the table; work stands and sorters are at one side of the table. The table was operated at a constant speed of 35 feet per minute for both first and second sortings.

For initial sortings, a nine-man crew was used. Ripes, pinks, and turns (including breakers) were sorted into lugs on the work stands. Rejects and culls were tossed into pails. Green fruit was run off at the end of the belt.

One worker opened, dumped, closed, and set aside empty crates. Of five sorters, the three

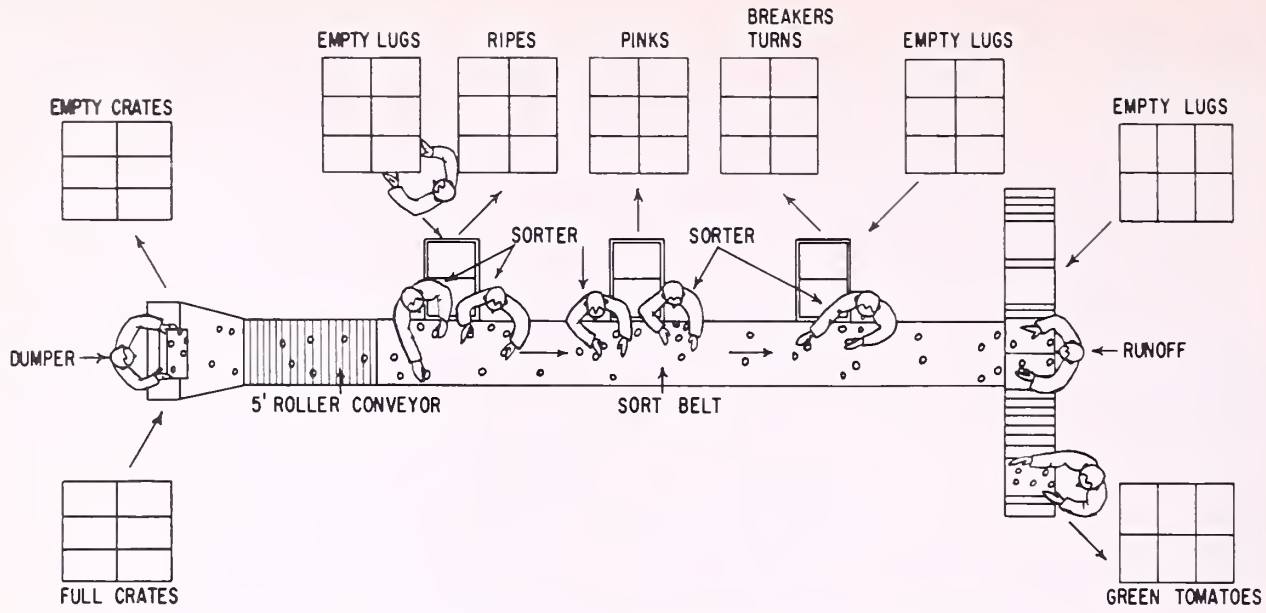


FIGURE 9.—A nine-man crew sorted tomatoes at this belt sorting table. Rejects and culls were placed in pails under the table.

nearest the dumper sorted out ripe and pink fruit into lugs and most of the rejects and culls into pails; the other two sorters lifted and placed turning fruit (including breakers) in lugs, and tossed out rejects or culls missed by the other sorters. Two workers handled the green fruit run off the end of the belt; the first worker broke out and placed empty lugs on the roller conveyor and pushed them forward to the second worker, who filled lugs and leveled the fruit; the first worker also transported and stacked full lugs in unit loads. The ninth member of the crew broke

TABLE 5.—*Labor requirements per 1,000 pounds for first and second sortings of tomatoes by color and size, by specified crews, on a 3-lane roller table and packing bins (speed of table, 16 feet per minute)*[1]

Time item	First sorting [2]		Second sorting [3]	
	Crew [4]	Labor required	Crew [5]	Labor required
	Number	*Man-hours*	*Number*	*Man-hours*
Productive labor:				
Open and dump	1	0. 120	1	0. 165
Sort	4	. 840	3	. 744
Transport lugs and catch runoff in lugs	2	. 364	2	. 358
Total productive labor		1. 324		1. 267
Unproductive labor:				
Dumper waits for sorters	1	. 090	1	. 083
Wait for lugs to fill	2	. 056	2	. 138
Total unproductive labor		. 146		. 221
Total labor	7	1. 470	6	1. 488
Elapsed hours		. 2100		. 2480

[1] Fruit was carried from dumper in outside lanes. Greens, breakers, and turns were sorted into center lane and run off into lugs; pinks and ripes of 2 tray sizes were sorted into outside lanes (3's in one lane and 4's in the other) and run off onto 2 belt conveyors and shunted into packing bins by diagonal sweeps; culls were sorted onto one belt over center of table and run off into lugs; and rejects were sorted into pails.

[2] First sorting of fruit handled in 60-pound wirebound crates consisted of 820 pounds of greens, breakers, and turns, 130 pounds of pinks and ripes, 30 pounds of rejects, and 20 pounds of culls.

[3] Second sorting of fruit handled in 20-pound lugs consisted of 720 pounds of greens, breakers, and turns, 200 pounds of pinks and ripes, 50 pounds of culls, and 30 pounds of rejects.

[4] Crew organization: One worker transports, opens, and dumps 60-pound wirebound crates and sets aside empty crates; 4 workers sort (2 on each side of table); and 2 workers break out empty lugs, place them under runoff chutes, fill, and transport to unit loads.

[5] Crew organization: One worker dumps 20-pound lugs and sets aside empty lugs; 3 workers sort on one side of table (fruit was carried from dumper in only one outside lane); and 2 workers break out empty lugs, place under runoff chutes, fill, and transport to unit loads.

out and placed empty lugs on stands beside sorters, and transported full lugs of ripe, pink, and turning fruit from stands to unit loads.

Another sorter was added to the crew for second sortings because more fruit had to be lifted, inspected, and placed in lugs. For these sortings, the three workers near the dumper sorted out ripes and pinks and most of the rejects. The other three sorters inspected greens for quality and lifted and placed turning and breaking fruit in lugs.

Table 6 shows labor requirements for an initial sorting of 1,000 pounds of tomatoes by a 9-man crew and a second sorting by a 10-man crew. In the initial sorting, the worker breaking out empty lugs for sorters and transporting full lugs from sorting stations to unit loads was unproductive half of the time; for every 1,000 pounds of tomatoes sorted, only 18 lugs were needed to handle fruit showing color. The production rate for a first sorting crew was almost 6,800 pounds per hour. In the second sorting, the two workers at the end of the sorting table accounted for most of the 0.179 man-hour of unproductive time, because only 30 percent of the fruit (green) was run off.

Comparison of Five Tomato Sorting Systems

Labor and equipment costs for first and second sortings of tomatoes by the five systems described are shown in table 7. These costs are based on dumping 1,000 pounds of tomatoes at the sorting table for each sorting.

The 4-lane roller table with a 10-man crew had the lowest costs for first and second sortings. The next lowest costs were for the same system with a five-man crew. These were the largest and smallest crews used in any of the five systems. Translation speed of the table was adapted to the number of sorters used.

In general, the most important factors contributing to sorting efficiency are (1) the type of table and (2) coordination of translation speed of the table with the number of sorters.

Roller tables with lanes, properly used, require less manual labor than belt tables. Tomatoes can be inspected with little or no handling by the sorters, and at least three colors of fruit can be run off the end of the table.

TABLE 6.—*Labor requirements per 1,000 pounds for first and second sortings of tomatoes, by specified crews, using a belt sorting table operated at 35 feet per minute* [1]

Time item	First sorting [2]		Second sorting [3]	
	Crew [4]	Labor required	Crew [5]	Labor required
	Number	*Man-hours*	*Number*	*Man-hours*
Productive labor:				
Open and dump	1	0. 120	1	0. 165
Sort	5	. 737	6	1. 055
Transport lugs	1	. 074	1	. 124
Catch runoff in lugs	2	. 268	2	. 236
Total productive labor		1. 199		1. 580
Unproductive labor:				
Dumper waits for sorters	1	. 027	1	. 011
Wait for full lugs	1	. 074	1	. 052
Wait for lugs to fill	2	. 027	2	. 116
Total unproductive labor		. 128		. 179
Total labor	9	1. 327	10	1. 759
Elapsed hours		. 1475		. 1759

[1] Green fruit was run off end of belt into lugs, turns (including breakers), pinks, and ripes were sorted into lugs, and culls and rejects were sorted into pails.

[2] First sorting of fruit handled in 60-pound wirebound crates consisted of 600 pounds of greens, 220 pounds of breakers and turns, 80 pounds of pinks, 50 pounds of ripes, and 50 pounds of rejects and culls.

[3] Second sorting of fruit handled in 20-pound lugs consisted of 300 pounds of greens, 420 pounds of breakers and turns, 100 pounds of pinks, 100 pounds of ripes, and 80 pounds of culls and rejects.

[4] Crew organization: One worker transports, opens, and dumps 60-pound wirebound crates and sets aside empty crates; 5 workers sort on one side of belt; 1 worker breaks out empty lugs for sorters and transports full lugs from sorting stations; and 2 workers break out empty lugs, place them under runoff chute, fill and transport to unit load.

[5] Crew organization: One worker dumps 20-pound lugs and sets aside empty lugs; 6 workers sort on one side of belt; 1 worker breaks out empty lugs for sorters and transports full lugs from sorting stations; and 2 workers break out empty lugs, place them under runoff chute, fill, and transport to unit load.

TABLE 7.—*Labor and equipment costs per 1,000 pounds for first and second sortings of tomatoes, using specified types of equipment and crew sizes, annual volume received 3,000,000 pounds*

Equipment type and sorting	Table speed [1]	Crew		Elapsed time	Labor required	Cost		
		Sorters	Total			Labor [2]	Equipment [3]	Total
	Feet per minute	*Number*	*Number*	*Hours*	*Man-hours*	*Dollars*	*Dollars*	*Dollars*
4-lane roller table:								
First sorting	36	4	10	0. 0600	0. 600	1. 20	0. 08	1. 28
Second sorting	36	4	10	. 0825	. 825	1. 65	. 11	1. 76
First sorting	30	2	5	. 1770	. 885	1. 77	. 11	1. 88
Second sorting	30	2	5	. 2250	1. 125	2. 25	. 14	2. 39
3-lane roller table:								
First sorting	30	5	9	. 1200	1. 080	2. 16	. 09	2. 25
Second sorting	30	5	8	. 1420	1. 136	2. 27	. 10	2. 37
Belt with packing bins:								
First sorting	32	4	7	. 1522	1. 065	2. 13	. 06	2. 19
Second sorting	32	3	6	. 2232	1. 339	2. 68	. 09	2. 77
3-lane roller table with packing bins:								
First sorting	16	4	7	. 2100	1. 470	2. 94	. 10	3. 04
Second sorting	16	3	6	. 2480	1. 488	2. 98	. 12	3. 10
Belt:								
First sorting	35	5	9	. 1475	1. 327	2. 65	. 09	2. 74
Second sorting	35	6	10	. 1759	1. 759	3. 52	. 11	3. 63

[1] These translation speeds do not necessarily represent the optimum speeds for given crew sizes.
[2] At $2.00 per hour.
[3] See table 52 in appendix for machine-hour requirements and cost computations.

Close inspection of tomatoes at a belt table requires that sorters either turn the tomatoes over on the table, or lift the fruit and inspect it in hand. Only one color can be run off a belt table; the rest of the fruit must be picked up and placed in containers.

The translation speed of the five sorting tables studied ranged from 16 to 36 feet per minute. The speed of 16 feet per minute for the 3-lane roller table with packing bins, using 4 sorters, was too slow. The sorters' time was not fully utilized even for lots of fruit containing a large percentage of culls and rejects. At all other tables, sorters were able to work at or near a normal rate, at the translation speeds used.

Of three roller tables studied, the four-lane gave the most even workload distribution among the sorters and required the least amount of lifting of fruit. The fruit moving past the sorters was divided into two lanes, so that each sorter inspected only half the total amount of fruit. Flow of fruit at the three-lane roller table with packing bins also was divided into two lanes, but the sorters were required to pick out green fruit (more than half the tomatoes) and place it in the center lane.

By combining breakers with turns, and pinks with ripes, all good fruit can be run off at both three- and four-lane roller tables. At three-lane tables, the fruit is carried down the center lane, and at four-lane tables, down the two outside lanes. Green fruit, after inspection, remains in these lanes and is run off at the end of the table. The color combinations are placed in the empty lanes. This practice is followed by most terminal market tomato repackers using roller tables.

Packing Methods and Equipment

Tomatoes repacked at terminal markets are packed in trays or tubes of three or four tomatoes each (tray-packing), or in place-pack cartons of 10, 20, or 28 pounds (place-packing). The quantities packed in trays in the plants studied ranged from about 30 to 90 percent of the total fruit packed; the majority of plants averaged 85 percent.

The tomatoes undergo a final sorting or inspection at the tray-packing line. The fruit received at the packing line is composed of the pink and ripe tomatoes that come directly from the sorting line and the ripened breakers and turns that come directly from the ripening rooms. Instead of sorting the ripened breakers and turns again at large roller or belt tables, most repackers move them directly from ripening rooms to the packing line, to minimize handling and bruising.

The final sorting and the sizing of tomatoes into 3's, 4's and place-pack fruit are done at tray-packing lines and are therefore included in the costs of tray-packing. Place-packing is a separate operation.

Tray-Packing

Both paperboard and plastic trays are used for packing tomatoes. The paperboard tray has undergone many changes and improvements since first introduced to the tomato-packing industry, and the major objection of limited visibility of the contents has largely been overcome.

This tray can be set up by an erecting machine or by hand. The newer plastic tray permits better inspection of the contents, but at the time this study was made, plastic trays were set up only by hand. After trays are filled, they are wrapped with film in an overwrap machine. Plants that used plastic trays reduced the operating speed of the overwrap machine below that used for paperboard trays, to prevent tipping of trays as they entered the machine. Labor and equipment costs for the 6 packing systems studied are based on the use of paperboard trays.

Work performed at tray-packing lines includes: (1) Sorting out culls, rejects, and unripe fruit; (2) sizing the tomatoes into 3's, 4's, and place-pack fruit; (3) dividing each tray size further into small fruit for the ends of trays and larger fruit for the middle; (4) separating tray-size fruit and, in some cases, place-pack fruit, by color (red and light red); and (5) placing the fruit in trays.

These tasks are not necessarily grouped or performed at any repacking plant in the sequence just listed. In some plants, one set of workers does all the sorting, sizing, and color separation in one operation (fig. 10); in others, the work is grouped into two or three operations and done by two or three different sets of workers.

Equipment used at tray-packing lines consists of overwrap machines, belt conveyors for trays, and erecting machines to set up trays. At only one of the tray-packing lines studied, the workers set up trays by hand (fig. 11). Separate erecting machines, belt conveyors, and overwrap machines are used for the two tray sizes. Various other pieces of equipment—roller or belt sorting tables, packing bins, or lugs—are used.

About 1,250 pounds of tomatoes must be sorted to obtain 1,000 pounds of ripe, packageable, tray-size fruit. In the plants studied, of 1,250 pounds of fruit moved from ripening rooms to the packing line, about 125 pounds was sorted out as culls and rejects and 125 pounds because the fruit was too large to pack in trays or not ripe enough (breakers and turns).

BN-17248

FIGURE 11.—After erecting tray by hand, packer selects and places one tomato at a time in the tray.

Packing filled trays in master containers and placing the containers in unit loads are also included in the work done at the tray-packing line (fig. 12).

In addition to different methods used in sorting and sizing tomatoes at the packing lines, repackers

BN-17253

FIGURE 10.—Packers filling trays from lugs. Each worker makes all decisions about color, size, and quality of the tomatoes.

BN-17256

FIGURE 12.—This worker has placed 10 trays in a master container and is about to shape and close the hinge cover.

use two different general methods of filling trays, described here as the partial-fill and complete-fill methods. In the partial-fill method, each worker places one or two tomatoes in a tray (fig. 13).

BN-17238

FIGURE 13.—In this method of packing, each worker places one or two tomatoes in the trays as they move past on the conveyor belt.

In the complete-fill method, each worker places all the tomatoes required in the tray. The six systems studied are discussed on the basis of tray-filling method.

Partial-Fill Method

Roller-belt sorting tables and packing bins.— Equipment consisted of a 10-foot, single-lane, roller sorting table, a 60-foot belt sorting table, three packing bins, two tray setup machines with 6-inch belt conveyors for trays, and two tray overwrap machines. Total number of workers was 17. Separate crews were used to (1) sort out culls and rejects, (2) divide fruit by size and color, and (3) pack fruit. Arrangement of the equipment and workers is shown in figure 14. Unripe fruit was run off the end of the belt sorting table.

The three-man crew at the roller sorting table consisted of a dumper and two sorters. The sorters placed culls in lugs, and rejects in steel drums. Besides dumping fruit at the table, the dumper placed empty containers on stands opposite the sorters, and full containers in unit loads. Sound fruit was run off onto the belt table.

Five workers spaced along the belt sorting table, opposite the three packing bins, sorted fruit by size and color. One packing bin for large fruit was divided into sections for red and light-red fruit. The second packing bin, for size 4 tomatoes, was divided into four sections, for small red fruit, large red fruit, small light-red fruit, and large light-red fruit. The third packing bin, for size 3, was similarly divided into four sections. (The tray-packing lines were opposite the sorters, on the other side of the packing bins for 3's and 4's.)

The work assignments of the five workers varied. When the lot of fruit ran mainly to 4's, one worker sorted place-pack-size fruit from the belt into two colors; three workers sorted small and large 4's by color; and one worker sorted small and large 3's by color and handled runoff of fruit not ripe enough for packing.

A nine-man crew was used to tray-pack 4's. One worker obtained cartons of knocked-down trays from storage, placed trays in the setup machine, and started and stopped the machine. Five workers filled trays. As empty trays moved down the belt from the setup machine, the first two packers placed small tomatoes of similar color in the ends of the trays. The other three packers placed and positioned the two larger center tomatoes in trays and adjusted all four tomatoes for the best fit. A worker stationed near

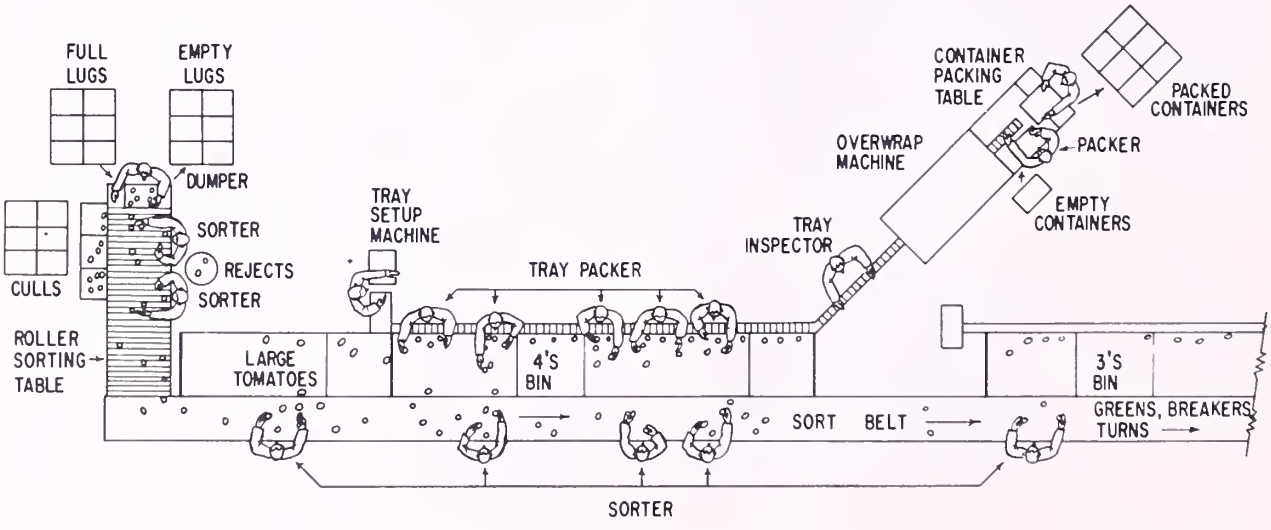


FIGURE 14.—A 17-man crew was used with this partial-fill tray-packing system. Eight workers inspected and sorted the fruit for quality, color, and size, while nine workers packed.

the overwrap machine gave each tray a cursory inspection and fed the trays into the machine; this worker also replenished the supply of film in the overwrap machine. Two workers at the end of the packing line segregated trays by color, and filled, closed, and stacked master containers in unit loads.

When size 3 tomatoes were packed, the crew moved to the 3's packing line with the same work assignments, except that one of the workers packing center tomatoes was dropped. This worker was assigned to place-packing, assembling master containers, or other work.

The packing crew worked independently of the sorting and sizing crews, and labor requirements were figured separately. Table 8 shows labor requirements for sorting 1,250 pounds of tomatoes for quality, color, and size. The relatively small unproductive time of 0.030 man-hour was incurred by the three workers sorting for quality on the roller table.

Labor requirements for packing 1,000 pounds of tomatoes in size 4 trays are shown in table 9. Unproductive time amounted to about 10 percent of the total labor.

Total labor for sorting and packing was 4.292 man-hours per 1,000 pounds of packed fruit. This system had the highest production rate of the six systems studied.

TABLE 8.—*Labor requirements for an 8-man crew to inspect and sort 1,250 pounds of tomatoes for quality, color, and size on combination single-lane roller-belt sorting table* [1]

Time item	Crew [2]	Labor required
	Number	*Man-hours*
Productive labor:		
Sort on roller table:		
Dump 20-pound lugs	1	0.206
Sort for quality	2	.482
Transport 5 empty lugs to and 5 lugs of culls from line	1	.020
Total	3	.708
Sort on belt table:		
Sort for color and size	5	1.228
Total productive labor		1.936
Unproductive labor:		
Dumper waits on 5 sorters	1	.020
2 sorters wait on 5 sorters	2	.010
Total unproductive labor		.030
Total labor	8	1.966
Elapsed hours		.2456

[1] Of the 1,250 pounds sorted on the roller table, to obtain 1,000 pounds of packageable fruit, about 10 percent was sorted out because of quality, and of the remaining fruit passed onto the belt table, about 10 percent was run off into lugs or sorted into place-pack bins.

[2] Crew organization: One worker dumps 20-pound lugs and transports empty lugs to, and full lugs from, sorting stations at roller table; 2 workers sort at roller table; and 5 workers sort at belt table and catch runoff.

TABLE 9.—*Labor requirements for a 9-man crew to pack 1,000 pounds of tomatoes in size 4 trays from divided packing bins, by the partial-fill method* [1]

Time item	Crew [2]	Labor required
	Number	*Man-hours*
Productive labor:		
Place trays in setup machine	1	0.175
Fill trays	5	1.257
Inspect filled trays	1	.251
Pack and close tray master containers	2	.399
Insert roll of film in overwrap machine	1	.007
Total productive labor		2.089
Unproductive labor:		
Tray machine operator waits on tray fillers	1	.077
Wait for wrapped trays	2	.104
Wait while film is placed in machine	8	.056
Total unproductive labor		.237
Total labor	9	2.326
Elapsed hours		.2583

[1] 14-ounce trays. Less than 1 percent of fruit placed in bins was sorted out by packers because of quality, size, or color.

[2] Crew organization: One worker places trays in setup machine, 5 workers fill trays, 1 worker inspects filled trays and places film in overwrap machine, and 2 workers pack and close master containers.

Two-lane roller sorting table and packing bins.—Equipment for this tray-packing system consisted of a two-lane roller table, two distributing belt conveyors with a mechanical sweep, two packing bins (one for each tray size), two tray-erecting machines, two tray belts, and two overwrap machines. Arrangement of the equipment and the 10-man crew is shown in figure 15.

Fruit was sorted for tray size, quality, and ripeness on the two-lane roller table by three workers. A worker dumped the fruit into one lane or the other, depending on the size of fruit. Cull fruit, fruit too large for trays, and that not ripe enough to pack was tossed into lugs, and rejects into pails, by two sorters. The remaining good fruit was sorted into 3's and 4's, one size being sorted into the opposite lane. The good fruit was run off the table onto two distributing belts and diverted into the packing bins by a mechanical sweep. Of the fruit dumped at the roller table, about 13 percent was sorted out because of quality, size, and ripeness.

A seven-man crew was used to perform the tray-packing operation for both 3's and 4's. Five workers filled trays, placing one or two tomatoes in a tray as it moved by on the belt conveyor. The first tray-packer also placed trays in the setup machine. An inspector stationed near the overwrap machine examined fruit in all trays for quality, matching color, and best fit, and fed

683959 O—63——3

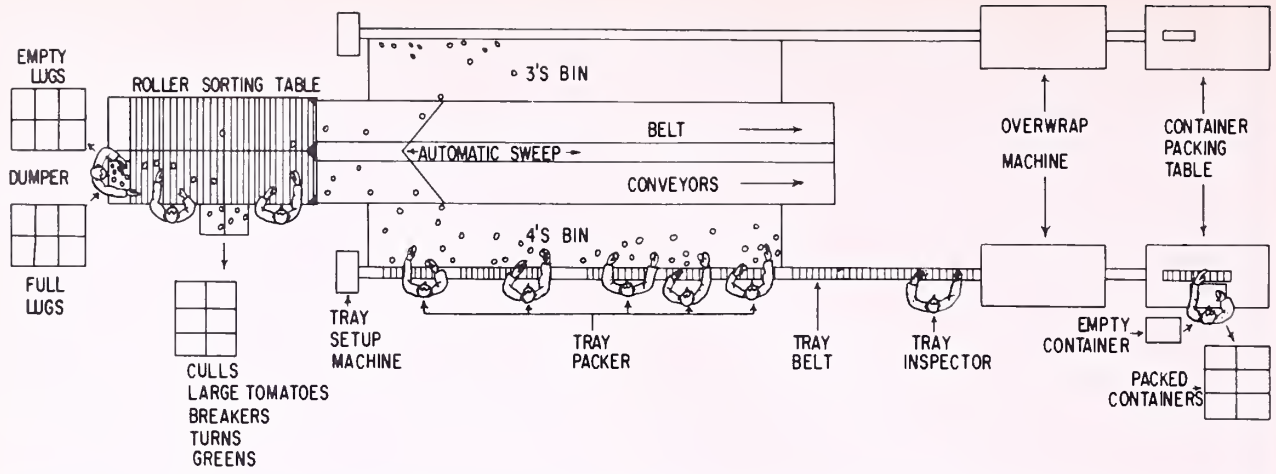


FIGURE 15.—A 10-man crew was used in this tray-packing system. Three workers were used on the two-lane roller table to sort the fruit for quality and for place-pack and tray sizes; the two tray sizes, run off in lanes, were distributed in bins by belt conveyors and a mechanical sweep. Using the partial-fill method, the remaining seven workers packed trays.

filled trays into the machine; he also placed rolls of film in the overwrap machine and made necessary adjustments of the machine. One worker filled, closed, and stacked tray master containers in unit loads.

In addition to filling trays, the packers sorted the fruit for matching color and selected sizes for placing in the ends and centers of trays. The last packer on the line often experienced difficulty in selecting tomatoes of the right size and color (fig. 16). When this packer was unable to locate such fruit, production was temporarily halted while he sorted through the fruit in the bin.

BN-17239

FIGURE 16.—Placing the last tomato in a partially filled tray. The packing rate for this partial-fill method declines when the supply of fruit in the bin is depleted, or filled trays containing a mix of colors have to be repacked, or too many unfilled trays are conveyed to the last packer.

When this occurred, other members of the packing crew were slowed down or made idle.

The sorting and packing crews worked independently of each other. Labor requirements to inspect and sort 1,250 pounds of tomatoes on the two-lane roller table are shown in table 10.

Table 11 shows the labor requirements for packing 1,000 pounds of tomatoes—four tomatoes per tray—for a seven-man crew when using a packing bin with the partial tray-filling method. Less than 5 percent of the total labor of 3.401 man-hours was unproductive. The rate of production was about 2,000 pounds per hour.

TABLE 10.—*Labor requirements for a 3-man crew to inspect and sort 1,250 pounds of tomatoes for quality, color, and size on a 2-lane roller sorting table* [1]

Time item	Crew [2]	Labor required
	Number	*Man-hours*
Productive labor:		
Dump 20-pound lugs	1	0.206
Sort for quality, color, and size	2	.889
Transport 11 empty lugs to, and 11 lugs from, sorting table	1	.028
Total productive labor	3	1.123
Unproductive labor:		
Dumper waits for 2 sorters	1	.210
Total labor	3	1.333
Elapsed hours		.4443

[1] Of the 1,250 pounds sorted on the roller table, to obtain 1,000 pounds of packageable fruit, about 13 percent was sorted out because of quality and color by sorters and about 7 percent by tray packers.

[2] Crew organization: One worker dumps 20-pound lugs and transports empty lugs to, and full lugs from, sorting and packing stations; and 2 workers sort.

Total labor requirements for a 10-man crew for tray-packing, and the final inspection and sorting of fruit associated with packing, for the 2-lane roller table and packing bin system, were 4.734 man-hours per 1,000 pounds.

Lugs.—Two sets of lug racks, a two-level roller conveyor for lugs, two tray setup machines, two tray belt conveyors, and two overwrap machines were the equipment used with this system. The arrangement of the equipment and work stations of the eight-man crew is shown in figure 17.

TABLE 11.—*Labor requirements for a 7-man crew to pack 1,000 pounds of tomatoes in size 4 trays from a packing bin, using the partial-fill method* [1]

Time item	Crew [2]	Labor required
Productive labor:		
Place trays in setup machine and fill trays	*Number* 5	*Man-hours* [3]2. 394
Inspect filled trays	1	. 479
Pack and close tray master containers	1	. 399
Insert roll of film in overwrap machine	1	. 007
Total productive labor		3. 279
Unproductive labor:		
Wait for wrapped trays	1	. 080
Wait while film is placed in machine	6	. 042
Total unproductive labor		. 122
Total labor	7	3. 401
Elapsed hours		. 4858

[1] 14-ounce trays. Seven percent of fruit placed in bin was sorted out by packers because of quality.
[2] Crew organization: Five workers fill trays, 1 worker inspects filled trays and places film in overwrap machine, and 1 worker packs and closes tray master containers.
[3] Includes transporting trays from storage (0.012 man-hour) and placing in setup machine (0.163 man-hour), and filling trays (2.19 man-hours).

One worker moved lugs of tomatoes to the roller conveyor and from the conveyor to the lug racks. This worker also moved and placed lugs emptied by packers on another roller conveyor, located above the full-lug conveyor, pushed them to the end of the conveyor, nested them, and stacked them in a load or temporary storage; he also placed trays in the setup machine. The six packers selected tomatoes from lugs and, after inspecting for quality, size, and color, placed one or two in a tray moving down the tray belt; the last packer also inspected trays for quality, matching color, and best fit. One worker packed, closed, transported, and stacked 10-tray master containers in unit loads. The worker filling and closing master containers also placed rolls of film in the overwrap machine.

In this system, a packer was required to inspect a tomato for quality, size, and color before placing it in a tray. If the fruit selected from a lug was not ripe enough for packing, it was placed in a lug beneath or atop the lug rack. If it was defective, it was either placed in a garbage pail or tossed into another lug for culls. If it was ripe enough for packing, but too large for trays being packed, it was placed in another lug. If the tomato was ripe and of proper tray size, the packer then faced the task of matching the color of the tomato in his hand with that of fruit in a partially filled tray, and inserting it in the center or end of a tray. The errors made by five of the packers, involving fruit placed in trays, had to be corrected by the last packer. Often the entire tray-packing operation was stopped while this packer-inspector

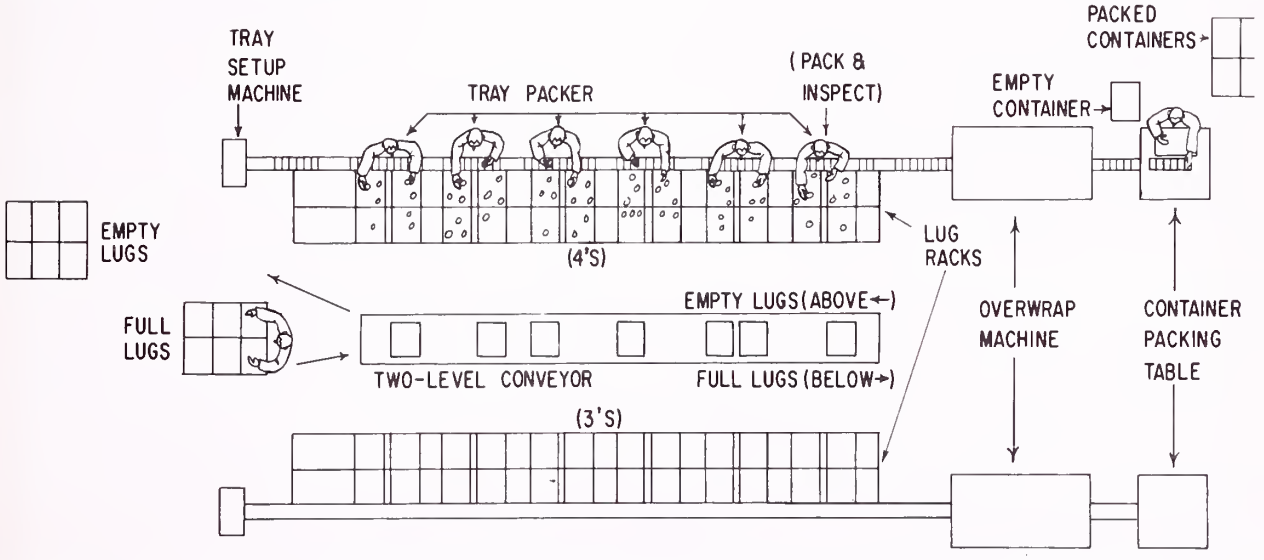


FIGURE 17.—In this packing system, using the partial-fill method, trays are filled from lugs of unsorted fruit by an eight-man crew. Greens, breakers, turns, large tomatoes, and culls are sorted into lugs on top of the rack; rejects are placed in pails under the rack.

corrected these mistakes as to color and placement of fruit in the trays.

The inspection and sorting required of the six packers in this system are reflected in total labor requirements and the packing rate (table 12). Total labor needed to pack 1,000 pounds of tomatoes in trays (four tomatoes per tray) for this lug system was 5.022 man-hours. The production rate was about 1,600 pounds per hour—the lowest of all the systems studied.

TABLE 12.—*Labor requirements for an 8-man crew to pack 1,000 pounds of tomatoes in size 4 trays from lugs, using the partial-fill method* [1]

Time item	Crew [2]	Labor required
Productive labor:		
Place trays in setup machine and transport lugs	*Number* 1	*Man-hours* [3] 0.428
Sort and fill trays	6	3.724
Pack and close tray master containers	1	.399
Insert roll of film in overwrap machine	1	.007
Total productive labor		4.558
Unproductive labor:		
Tray machine operator waits on tray fillers	1	.193
Wait for wrapped trays	1	.222
Wait while film is placed in machine	7	.049
Total unproductive labor		.464
Total labor	8	5.022
Elapsed hours		.6278

[1] 14-ounce trays. Eighty percent of 1,250 pounds of fruit moved to packing line was placed in trays, and about 20 percent was sorted out by packers because of size, color, and quality.

[2] Crew organization: One worker places trays in setup machine and transports lugs of fruit to packing stations, empty lugs from packing stations, and lugs of fruit sorted out by packers to unit loads; 6 workers fill trays (worker near tray overwrap machine also inspects filled trays) and 1 worker packs and closes tray master containers and places film in overwrap machine.

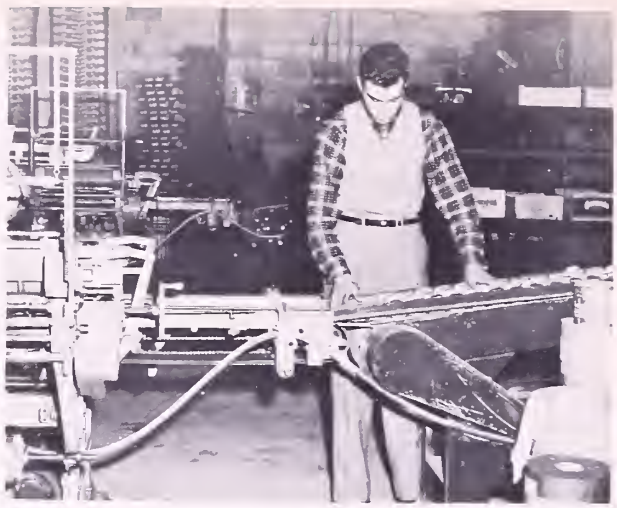
[3] Includes transporting trays from storage (0.012 man-hour) and placing in setup machine (0.163 man-hour) and transporting lugs of fruit to packers and lugs of culls and other fruit sorted out by packers, and empty lugs, from packing stations to unit loads (0.253 man-hour).

Complete-Fill Method

Lugs.—Types and arrangements of equipment for this system of filling trays from lugs in racks were the same as those of the lug system using the partial-fill method.

An 11-man crew was used to tray-pack 4's by this system. One worker handled lugs and one worker packed master containers, as described for the other lug system. Eight workers were used to perform the tray-filling operation. One worker inspected filled trays (fig. 18).

In filling a tray, using the complete-fill method, a packer removed an empty tray from the belt, placed it on a narrow ledge or shelf adjacent to the belt, selected, inspected, and placed two tomatoes of like color and size in the ends of the tray, selected and placed two more tomatoes in the center of the tray, adjusted all four for best fit, and placed the filled tray on the belt.



BN–17252

FIGURE 18.—Inspecting filled trays for defective fruit, matching color, and firm pack.

The inspector made adjustments of tomatoes in a single tray, or exchanged fruit in trays to obtain matching color and best fit. Occasionally the inspector removed from the belt several trays containing fruit of substandard quality or a mix of colors, rather than stop the tray belt; these trays were later filled by the inspector or one of the packers.

Labor requirements for packing 1,000 pounds of tomatoes by this system are shown in table 13. Unproductive time amounted to only 3 percent of total labor.

Although this system, like the lug system using the partial-fill method, placed all the responsibility for sorting, sizing, and matching color of tomatoes on the packers, the production rate of 2,220 pounds per hour was in the middle range of the six systems studied.

Use of a full-time inspector of filled trays accounts partly for the greater efficiency of this system over that of the lug system using the partial-fill method. Moreover, because each packer placed all the tomatoes required in a tray, any extra time spent in trying to fit tomatoes in trays did not interfere with other workers or hold up the packing line.

Belt sorting table and packing bins.—The arrangement of equipment used in this system and the work stations of the 12-man crew are shown in figure 19. The equipment consisted of a 24-inch by 60-foot sorting belt, two packing bins, two tray setup machines, two tray belts, two overwrap machines, and six packing boards on which trays were placed for packing.

TABLE 13.—*Labor requirements for an 11-man crew to pack 1,000 pounds of tomatoes in size 4 trays from lugs, using the complete-fill method* [1]

Time item	Crew [2]	Labor required
Productive labor:		
Place trays in setup machine and transport lugs	*Number* 1	*Man-hours* [3] 0.428
Sort and fill trays	8	3.603
Inspect filled trays	1	.450
Pack and close tray master containers	1	.399
Insert roll of film in overwrap machine	1	.007
Total productive labor		4.887
Unproductive labor:		
Tray-machine operator waits on tray fillers	1	.022
Wait for wrapped trays	1	.051
Wait while film is placed in machine	10	.070
Total unproductive labor		.143
Total labor	11	5.030
Elapsed hours		.4573

[1] 14-ounce trays. Eighty percent of 1,250 pounds of fruit moved to packing lines was placed in trays, and about 20 percent was sorted out by packers because of size, color, and quality.

[2] Crew organization: One worker places trays in setup machine, transports lugs of fruit to packing stations, empty lugs from packing stations, and lugs of fruit sorted out by packers to unit loads; 8 workers fill trays; 1 worker inspects filled trays and places film in overwrap machine; and 1 worker packs and closes tray master containers.

[3] Includes transporting trays from storage (0.012 man-hour) and placing them in setup machine (0.163 man-hour), and transporting lugs of fruit to tray packers and lugs of culls and other fruit sorted out by packers, and empty lugs, from packing stations to unit loads (0.253 man-hour).

The sorting and packing operations were performed independently. Four workers sorted, and eight were on the packing crew.

One worker dumped fruit onto an inclined chute at the head of the sorting table, and also removed most of the rejects. One worker sorted out size 4 fruit into a packing bin, and one sorted size 3 into the other packing bin. Both workers sorted culls and large tomatoes into lugs. The fourth man caught runoff of unripened fruit in lugs and transported empty lugs to, and full lugs from, sorting stations.

The good, sound fruit was placed in trays by six packers using the complete-fill method. In filling the trays, a packer placed several empty trays, obtained from the tray belt, on a 15- by 25-inch packing board; one end of the board rested on the edge of the packing bin and the other on the tray belt frame. Then the packer selected a tomato from the bin with one hand, transferred it to the other hand, and placed it in the tray. This procedure was repeated until the tray was filled; the tray was then placed on the tray belt leading to the overwrap machine. Each packer selected for small and large size and matching color. One of the tray packers also placed trays in the setup machine. An inspector of filled trays and a worker to pack tray master containers rounded out the eight-man packing crew.

Total labor requirements for packing 1,000 pounds of tomatoes in size 4 trays by the belt-bin system were 5.346 man-hours. Of this, 1.872 man-hours (table 14) were charged to the four-man sorting crew, and 3.474 man-hours (table 15) to the eight-man packing crew. Although the elapsed time for sorting (0.4678 hour) exceeded that for packing (0.4342 hour), no wait time was charged to the latter crew, since the two operations were performed independently of each other.

Three-lane sorting table and packing bins.—A three-lane roller sorting table with two runoff belts, like that shown in figure 8, was used with this tray-packing system. Fruit from the ripening rooms was dumped in one of the outside lanes. Unripe fruit was sorted into the center lane, run off into lugs, and returned to ripening rooms. Fruit too large for trays and culls were transferred to the two runoff belts. Rejects were tossed into

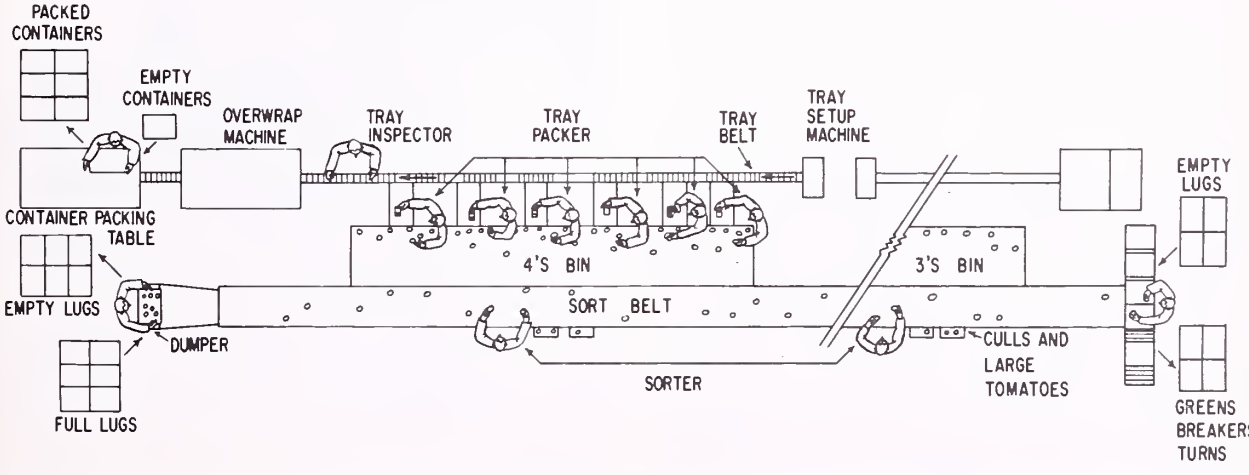


FIGURE 19.—In this tray-packing system, four workers inspected and sorted for quality, size, and color, while eight workers, using the complete-fill method, packed the trays.

TABLE 14.—*Labor requirements for a 4-man crew to inspect and sort 1,250 pounds of tomatoes for quality, size, and color on a belt sorting table* [1]

Time item	Crew [2]	Labor required
Productive labor:		
Dump 20-pound lugs and sort out rejects	*Number* 1	*Man-hour* 0.468
Sort for quality, color, and size	2	.936
Catch runoff and transport 5 empty lugs to, and 5 lugs of culls from, sorting stations	1	.468
Total	4	1.872
Elapsed hours		.4678

[1] Of the 1,250 pounds sorted on the belt table, to obtain 1,000 pounds of packageable fruit, about 10 percent was sorted out because of quality, and about 10 percent was run off the end of the belt into lugs.

[2] Crew organization: One worker dumps 20-pound lugs, sorts out rejects, and regulates flow of fruit onto belt; 2 workers sort for quality, size, and color; and 1 worker catches runoff and transports empty lugs to, and lugs of culls from, sorting stations.

TABLE 15.—*Labor requirements for an 8-man crew to pack 1,000 pounds of tomatoes in size 4 trays from packing bins, using the complete-fill method* [1]

Time item	Crew [2]	Labor required
Productive labor:		
Place trays in setup machine and fill trays	*Number* 6	*Man-hours* [3] 2.564
Inspect filled trays	1	.427
Pack and close tray master containers	1	.399
Insert roll of film in overwrap machine	1	.007
Total productive labor		3.397
Unproductive labor:		
Wait for wrapped trays	1	.028
Wait while film is placed in machine	7	.049
Total unproductive labor		.077
Total labor	8	3.474
Elapsed hours		.4342

[1] 14-ounce trays. Less than 1 percent of fruit placed in bin was sorted out by packers because of quality, size, or color.

[2] Crew organization: 6 workers fill trays; 1 worker inspects filled trays and places film in overwrap machine; and 1 worker packs and closes tray master containers.

[3] Includes transporting trays from storage (0.012 man-hour) and placing them in setup machine (0.163 man-hour), and filling trays with 1,000 pounds of fruit (2.388 man-hours).

pails. Ripe fruit of the predominant tray size was run off the table in the outside lane carrying the fruit from the dumper, while the other size was sorted into the other outside lane. The two tray sizes of fruit were run off the table onto two belt conveyors, and shunted into packing bins by a mechanical sweep. Tray setup machines, tray belt conveyors, and overwrap machines were at the outer side of the packing bins. Arrangement of the belt conveyors carrying fruit from the sorting table, the packing bins, and packing lines was similar to that shown in figure 15.

Seventeen workers were used with this tray-packing system. Final inspection and sorting of fruit was performed by a four-man crew on the roller table; this crew comprised a dumper and three sorters. The sorters also transported empty lugs to, and full lugs from, runoff collection bins. The packing operation was performed by a 13-man crew—11 tray packers, an inspector, and a worker to pack, close, and stack tray master containers in unit loads. The inspector also placed overwrap film in the machine.

An inefficient tray-filling method was used with this system. In filling trays, a packer first obtained, and placed in the bin, a supply of 40 to 50 knocked-down trays. The packer then set up a tray by hand by folding in the ends. Holding the tray in one hand, the packer selected and placed fruit of proper color and size in the tray with the other hand (fig. 20). In all other systems, workers were able to use both hands to place tomatoes in trays. The filled tray was set down on the tray belt, situated between the packer and bin.

Labor requirements for the four-man sorting crew to obtain 1,000 pounds of tray-size tomatoes are shown in table 16.

The required labor for packing 1,000 pounds of tomatoes in trays (four per tray), using the one-hand tray-filling method described, is shown in table 17. Of the productive time, 79 percent was required by the 11 packers to set up and fill trays.

Total man-hours required for sorting and packing were 7.158. Although the elapsed time per 1,000 pounds of packageable fruit was lower for sorting than for tray packing (0.3243 vs. 0.4508 hour), no unproductive time is shown for

BN-17250

FIGURE 20.—Labor requirements were high for this one-hand tray-filling method.

the four-man crew; by this system, the sorting and packing were performed independently. When packing bins were full, the sorting crew was shifted to: (1) Sorting newly arrived fruit or re-sorting fruit containing fewer ready-to-pack tomatoes, (2) place-packing fruit in cartons, or (3) assembling tray master containers.

A substantial increase in the efficiency of this system would be effected by having trays set up mechanically. This change would reduce the labor requirements by about 0.600 man-hour per 1,000 pounds packed. A narrow ledge or shelf on which packers would place trays that are being filled should be built beside the tray belt.

TABLE 16.—*Labor requirements for a 4-man crew to inspect and sort 1,250 pounds of tomatoes for quality, size, and color on a 3-lane roller table with runoff belts* [1]

Time item	Crew [2]	Labor required
Productive labor:	*Number*	*Man-hours*
Dump 20-pound lugs	1	0. 206
Sort for quality, size, and color, and transport 11 empty lugs to, and 11 filled lugs from, end of runoff belts	3	[3] . 973
Total productive labor		1. 179
Unproductive labor:		
Dumper waits on 3 sorters	1	. 118
Total labor	4	1. 297
Elapsed hours		. 3243

[1] Of the 1,250 pounds sorted on the roller table, to obtain 1,000 pounds of packageable fruit, about 10 percent was sorted out because of quality, and about 10 percent because of ripeness.
[2] Crew organization: One worker dumps 20-pound lugs, and 3 workers sort for quality, size, and color, and tend runoff chutes.
[3] Includes: Sorting (0.928 man-hour) and breaking out empty lugs, filling and transporting to unit loads (0.045 man-hour).

TABLE 17.—*Labor requirements for a 13-man crew to pack 1,000 pounds of tomatoes in size 4 trays from packing bin, using the complete-fill method* [1]

Time item	Crew [2]	Labor required
Productive labor:	*Number*	*Man-hours*
Set up and fill trays	11	[3] 4. 882
Inspect filled trays	1	. 444
Pack and close tray master containers	1	. 399
Insert roll of film in overwrap machine	1	. 007
Total productive labor		5. 732
Unproductive labor:		
Wait for wrapped trays	1	. 045
Wait while film is placed in machine	12	. 084
Total unproductive labor		. 129
Total labor	13	5. 861
Elapsed hours		. 4508

[1] 14-ounce trays. Less than 1 percent of fruit placed in bin was sorted out by packers because of quality, size, or color.
[2] Crew organization: 11 workers set up and fill trays, 1 worker inspects filled trays and places film in overwrap machine, and 1 worker packs and closes tray master containers.
[3] Consists of 0.775 man-hour to erect trays by hand and 4.107 man-hours to fill trays.

Comparative Labor and Equipment Costs for Six Tomato Tray-Packing Systems

Total labor and equipment costs for tray-packing 1,000 pounds of size 4 tomatoes by six systems are shown in table 18. These costs are greatly affected by the amount of sorting required of tray-packers. The most efficient system—that using the roller-belt sorting tables and divided packing bins—required no sorting by the tray-packers; the sorting and packing work was divided among three separate crews. One crew sorted the tomatoes for quality; a second crew sorted the fruit into place-pack and tray sizes by color, and also divided tray sizes into small and large fruit for the ends and centers of trays. The tray-packing crew had only to pick up tomatoes from the packing bins and place them in trays. The partial-fill method was effective in this system because the tray-packers did not have to search for fruit of the proper size or color.

The same system was also the most efficient for tray-packing size 3 tomatoes (table 19). Total costs for packing 3's by this system were slightly higher than for packing 4's, because the slower filling rate increased equipment costs. Labor costs were approximately the same.

In addition to low total costs, the system using roller-belt sorting tables and packing bins also had the highest production rate for tray-packing size 4 tomatoes. The rate of production is important to some terminal market repackers, because fruit is usually packed as sales orders are received. Packing trays in anticipation of sales a day or two hence would reduce the retail-store shelf life of the fruit. Production rates for the six tray-packing systems studied are:

	Pounds packed per hour
Roller-belt sorting tables and packing bins	3, 870
Belt sorting table and packing bins	2, 300
3-lane roller sorting table and packing bins	2, 220
Lugs (complete-fill packing method)	2, 190
2-lane roller sorting table and packing bins	2, 060
Lugs (partial-fill packing method)	1, 590

Place-Packing

The volume of fruit place-packed in 10-, 20-, and 28-pound containers varies between terminal market repackers. For those plants where studies were made, the portion packed in these containers averaged about 15 percent of the total volume.

TABLE 18.—*Labor and equipment costs for tray-packing 1,000 pounds of tomatoes, 4 tomatoes per 14-ounce tray, by 6 packing systems (annual volume received: 3,000,000 pounds)*

System [1]	Packing method	Crew	Labor required	Cost		
				Labor [2]	Equipment [3]	Total
		Number	*Man-hours*	*Dollars*	*Dollars*	*Dollars*
Roller-belt sorting tables and packing bins	Partial-fill	17	4. 292	8. 58	1. 41	9. 99
Lugs	Complete-fill	11	5. 030	10. 06	2. 11	12. 17
2-lane roller table and packing bins	Partial-fill	10	4. 734	9. 47	2. 87	12. 34
Belt sorting table and packing bins	Complete-fill	12	5. 346	10. 69	2. 18	12. 87
Lugs	Partial-fill	8	5. 022	10. 04	2. 89	12. 93
3-lane roller table and packing bins	Complete-fill	17	7. 158	14. 32	2. 30	16. 62

[1] Sorting and packing methods used with each system are described in this section of the report under "Partial-Fill Method" and "Complete-Fill Method."

[2] At $2.00 per hour.

[3] See table 54, appendix, for machine-hour requirements and costs.

TABLE 19.—*Labor and equipment costs for tray-packing 1,000 pounds of tomatoes, 3 tomatoes per 14-ounce tray, by 5 packing systems* [1] *(annual volume received: 3,000,000 pounds)*

System [2]	Packing method	Crew	Labor required	Cost		
				Labor [3]	Equipment [4]	Total
		Number	*Man-hours*	*Dollars*	*Dollars*	*Dollars*
Roller-belt sorting tables and packing bins	Partial-fill	16	4. 284	8. 57	1. 55	10. 12
Lugs	Complete-fill	9	4. 321	8. 64	2. 21	10. 85
2-lane roller sorting table and packing bins	Partial-fill	10	4. 443	8. 89	2. 71	11. 60
Belt sorting table and packing bins	Complete-fill	12	5. 232	10. 46	2. 12	12. 58
3-lane sorting table and packing bins	Complete-fill	16	6. 182	12. 36	2. 06	14. 42

[1] Data were incomplete for tray-packing size 3 tomatoes for the lug system using the partial-fill packing method.

[2] Sorting and packing methods used with each system are desribed in this section of the report under "Partial-Fill Method" and "Complete-Fill Method."

[3] At $2.00 per hour.

[4] See table 55, appendix, for machine-hour requirements and costs.

A wide variety of place-pack containers are used by repackers. The oldest type of container is the overhandle basket made of splint or fiberboard. In recent years, the fiberboard carton has become popular. Fiberboard cartons are of many sizes and types. The most popular are two-piece cartons for packs of one, two, or three layers, holding 10 or 20 pounds of fruit. The standard wood lug (holding about 28 pounds) is used mainly for fruit sold to the armed forces and some institutions.

The method used to place-pack fruit in cartons is an important cost factor. Three packing methods were studied. These were (1) loose pack, (2) cup pack, and (3) paper wrap. The loose pack, in which the fruit is packed in layers without cups or wrappers, is used with carton packs of one, two, and three layers. Paper cups are used for single-layer, 10-pound packs, and for the top layer of some two-layer packs. The 4-inch-square paper wrapper is used in packing all types of cartons, from the 10-pound fiberboard carton to the 28-pound lug.

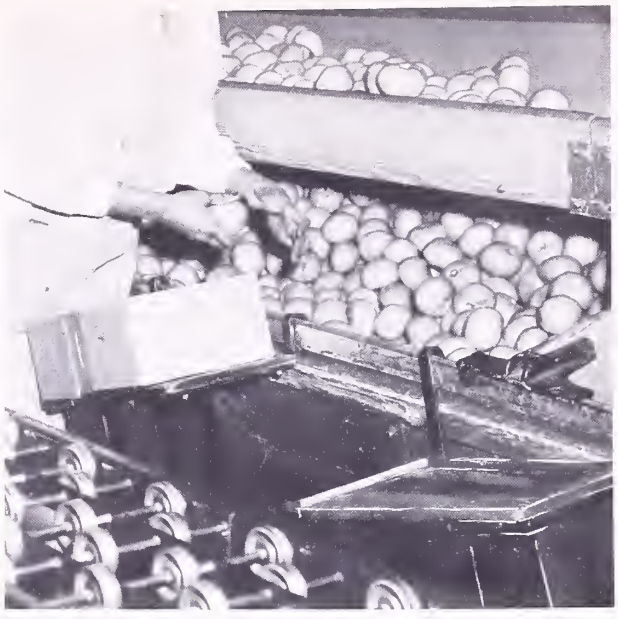
A portable packing stand is preferred by many repackers for filling place-pack cartons. It can be used in packing from bins or lugs. The working surface of the stand holds the carton or lug, in an inclined position, and the paper cups or wrappers; a shelf can be built into the stand for cardboard dividers used with packs of two or more layers of fruit. A well-arranged packing stand is shown in figure 21.

For loose packs, a detachable shelf-like device, like that shown in figure 22, made of wood and iron strapping, can be used to advantage, since it is small and compact, and can be quickly changed from one bin location to another. Note the position of the carton, close to the bin, and at bin height; little arm and hand movement is required to transfer fruit from bin to carton.

Similar methods were used to fill cartons and lugs. The packer, after positioning the portable packing stand beside the bin and getting supplies of cartons, cups or paper wrappers, and dividers, filled a container by grasping a tomato in the bin with one hand, and simultaneously grasping a cup or wrapper with the other hand. After inspecting the tomato for quality and color, he brought his hands together and placed the cup or wrapper around the tomato by closing a hand.

BN-17251

FIGURE 21.—A well-designed stand for place-packing tomatoes in cartons or lugs.



BN-17243

FIGURE 22.—A small, inexpensive device made of wood and iron strapping is used for packing 10- and 20-pound cartons.

Then, with one hand, he placed the wrapped or cupped fruit in the container. In the loose-pack method, a packer selected a tomato in each hand and, after inspecting them for quality and color, placed them in the carton. For packs of two or more layers, a cardboard divider was placed between each two layers. The filled container was then placed on a wheel or roller conveyor and rolled forward to the weighing and closing station. A worker at this station rolled the cartons from the conveyor onto the scale, and, after checking them for correct weight, placed covers on them. The closed containers were then pushed forward on the conveyor, and loaded into stacks.

The types of place-pack cartons and filling methods analyzed and compared were: (1) Ten-pound carton, two-layer loose pack; (2) 10-pound carton, single-layer cup pack; (3) 10-pound carton, two-layer paper wrap; (4) 20-pound carton, two-layer loose pack; (5) 20-pound carton, two-layer loose and cup pack (first layer packed loose and top layer in cups); and (6) 28-pound lug, paper wrap. For the six package types, one packer also checked the weight, placed the cover on the carton, or nailed the cover on the lug, and placed the closed container in a unit load.

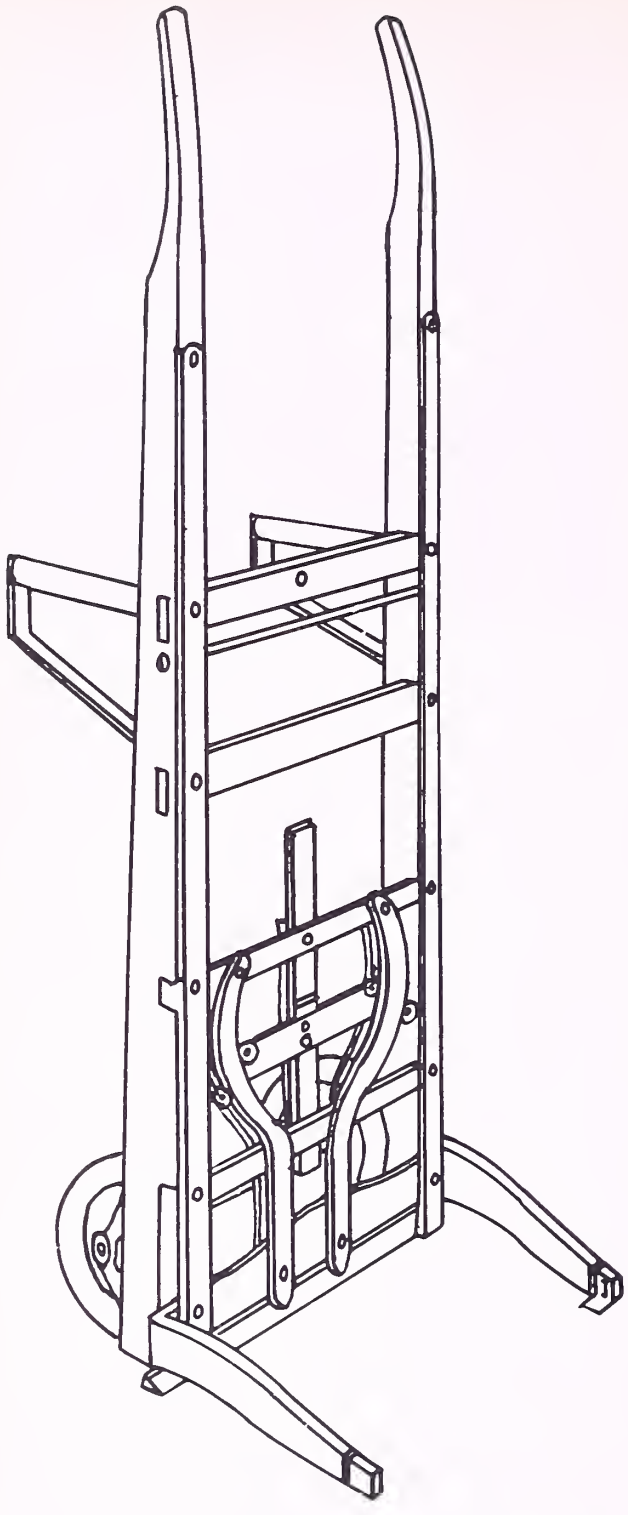
In plants where studies were made, packers worked independently, and the usual place-pack crew consisted of three workers. The detachable shelf was used with one- and two-layer loose packs, and the portable packing stand with the

TABLE 20.—*Labor and equipment costs for place-packing 1,000 pounds of tomatoes from bins by 3 workers in specified types of containers*

Container size and method	Elapsed time	Labor required	Cost		
			Labor [1]	Equipment [2]	Total
10-pound carton:	*Hours*	*Man-hours*	*Dollars*	*Dollars*	*Dollars*
2-layer loose pack	0. 6567	1. 970	3. 94	0. 44	4. 38
Single-layer cup pack	. 8867	2. 660	5. 32	. 64	5. 96
2-layer paper wrap	1. 0000	3. 000	6. 00	. 72	6. 72
20-pound carton:					
2-layer loose pack	. 5417	1. 625	3. 25	. 38	3. 63
2-layer loose and cup pack [3]	. 5767	1. 730	3. 46	. 44	3. 90
28-pound lug:					
Paper wrap	1. 1673	3. 502	7. 00	. 86	7. 86

[1] At $2.00 per hour.
[2] See table 56, appendix.
[3] First layer loose packed and top layer cup packed.

683-959 O - 63 - 4



Neg. 6339-58(7) AMS

FIGURE 23.—A type of two-wheel clamp truck used for tomato handling

other four types of packs. Labor and equipment costs for place-packing 1,000 pounds of tomatoes by three workers using three filling methods for three container sizes are shown in table 20. Of the six types of packs studied, the loose-pack method at $3.63 per 1,000 pounds, and the combination loose and cup pack method at $3.90, for 20-pound, two-layer cartons, showed the lowest total costs. The two-layer loose-pack method had the lowest cost ($4.38) of the three methods for 10-pound packs. The paper-wrap method for 28-pound lugs, at $7.86, had the highest total cost, with the paper-wrap 10-pound carton next highest, at $6.72 per 1,000 pounds. The elapsed time for the 20-pound loose-pack method, 0.5417 hour per 1,000 pounds, was the lowest of all methods studied.

Handling Operations and Equipment

Handling involves the movement of containers of tomatoes into, within, and out of the terminal-market repacking plant. Of less importance is the handling of empty shipping containers, and of empty lugs to and from the lug storage area. Handling productivity is measured in terms of units (pounds, tons, etc.) handled per man-hour.

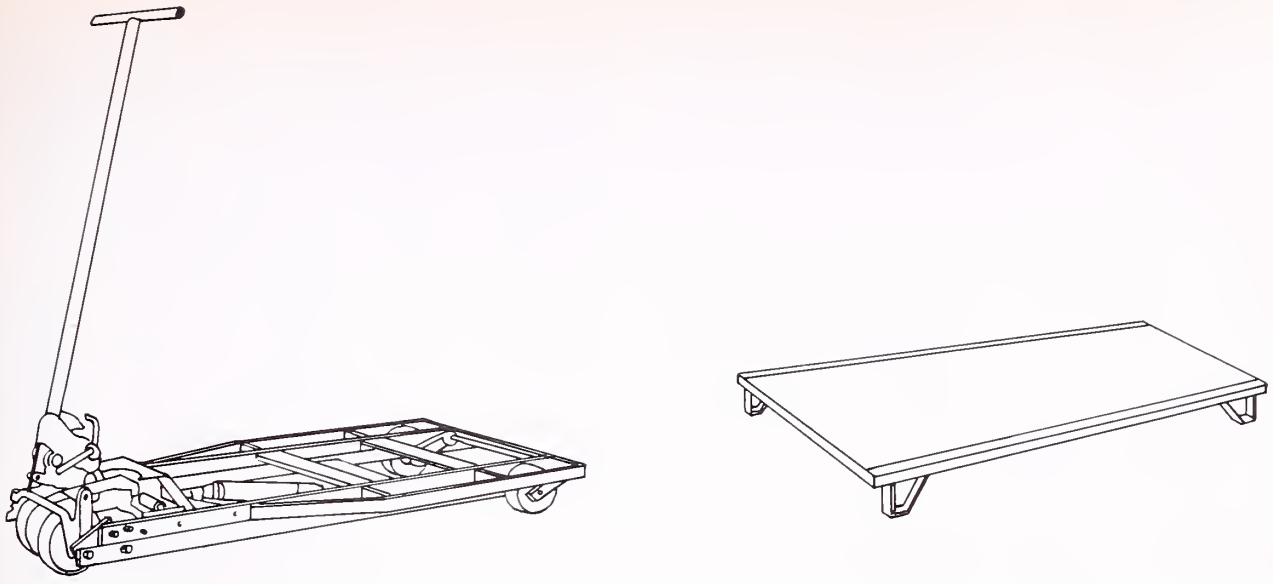
Types of Handling Equipment

The types of handling equipment analyzed are used by many tomato repackers. These are: (1) Two-wheel clamp truck, (2) dead skid and manual low-lift platform truck, and (3) pallets and electric pallet transporter.

Figure 23 shows a two-wheel clamp truck used for tomato handling. It is lightweight and can be maneuvered easily in congested areas. The clamping arms can be adjusted to handle a wide range of package sizes. Sometimes a small wooden flat or pallet is used to make it possible for a clamp truck to handle tray master containers and place-packed cartons of tomatoes. Unit loads remain intact when placed in the ripening rooms or storage area. Since the two-wheel clamp truck has a limited capacity, its principal use should be in repacking plants with relatively small annual volumes.

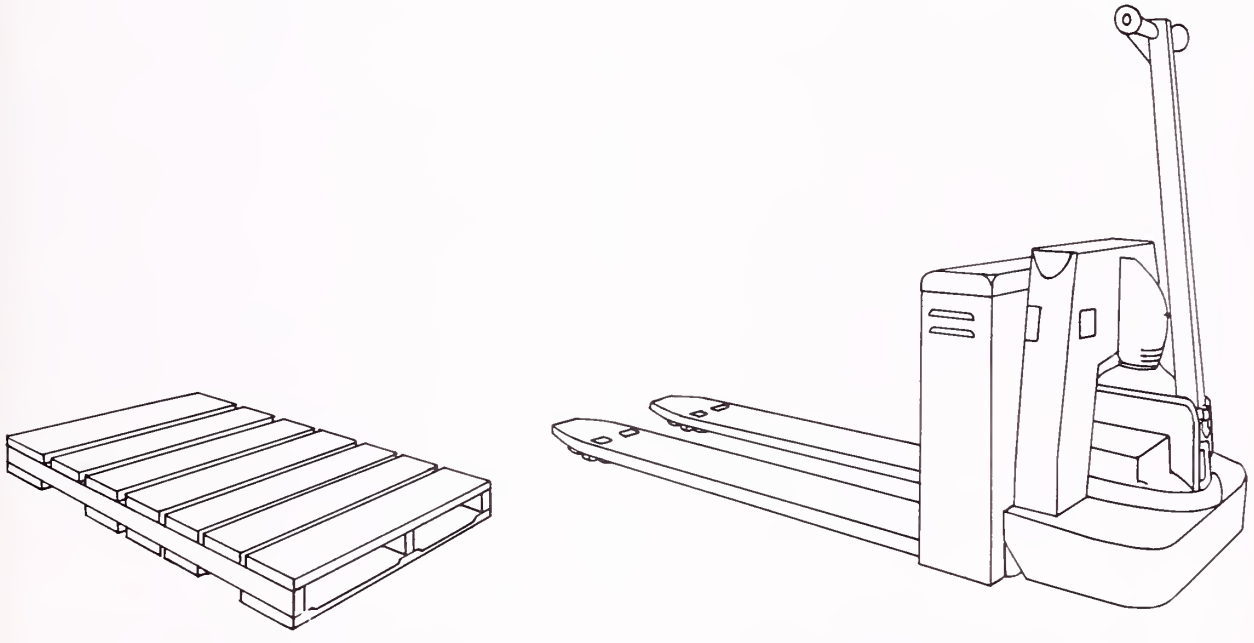
Dead skids with manual low-lift platform trucks (fig. 24) have a much greater capacity than two-wheel clamp trucks. Unit loads built on skids remain intact in storage. Dead skids and platform trucks are not as maneuverable as the two-wheel clamp trucks, but they can be operated satisfactorily in congested sorting and packing areas.

The unit-load principle of handling and storage is used also with the pallet and electric pallet transporter (fig. 25). This equipment is also capable of moving large unit loads. The maneuverability of the electric pallet transporter in the working area is comparable to that of the dead skid and platform truck. When warranted



U.S. DEPARTMENT OF AGRICULTURE NEG. 6342-58(7) AGRICULTURAL MARKETING SERVICE

FIGURE 24.—Dead skid and low-lift platform truck.



U.S. DEPARTMENT OF AGRICULTURE NEG. 6344-58 (7) AGRICULTURAL MARKETING SERVICE

FIGURE 25.—Pallet and electric pallet transporter.

by business volume, a forklift truck can be used to tier pallets and make more complete use of storage areas.

Handling Operations

The use of these three types of equipment was analyzed for receiving into ripening rooms, transporting full and empty containers within the packing plant, and loading out packed fruit. Travel distances for all operations were standardized at 100 feet to permit valid comparisons.

Table 21 shows the unit loads used to compute labor and equipment costs.

Receiving

Receiving consists of unloading containers of tomatoes from a carrier, and moving them to and

placing them in a ripening room. The elements of work associated with receiving are: (1) Setup, (2) build unit loads, (3) transport, and (4) cleanup. Setup includes opening rail car or truck doors, getting and positioning a bridgeplate, obtaining handling equipment, and placing an extension light in the carrier, if needed. The containers are then stacked in unit loads in the carrier by one or two workers, depending upon the type of handling equipment used. The unit loads are transported to, and placed in, a ripening room. After the last container is removed from the carrier, the carrier and platform are swept clean. The handling equipment and bridgeplate are returned to their storage locations.

Crew sizes were selected to minimize labor requirements for receiving tomatoes in 60-pound wirebound crates for each of the three types of handling equipment. A three-man crew was selected for the two-wheel clamp truck system. Two workers picked up and transported five-high unit loads built on the bed of the carrier by the third worker. Two workers were selected for the dead skid and platform truck system. One worker built unit loads on the dead skids in the carrier, and one transported them to the ripening room. With pallets and the electric pallet transporter, one worker transported a unit load while one man loaded the pallets in the carrier.

Transporting Within Plant

In-plant handling operations are: (1) Transporting containers of tomatoes between ripening rooms and the working area, (2) transporting empty containers, and (3) transporting packed fruit to temporary storage or holding area. The work elements for transporting unit loads of loose or packed fruit to and from storage and of empty containers within the plant consisted of picking up the load, transporting it, and setting it down in the working area, ripening room, or storage. Using the unit-load principle, only one worker was required to perform these operations using two-wheel clamp trucks, skids and a platform truck, or pallets and a pallet transporter.

The labor required for transporting a unit load of 60-pound wirebound crates of tomatoes from the ripening room to the sorting table was based on these work elements: (1) Pick up the load, (2) transport the load 100 feet, (3) set down the load on the floor near the dumper, and (4) return empty 100 feet.

The transporting of unit loads of 20-pound lugs of fruit to and from ripening rooms is the most important of the in-plant handling operations. In performing the sorting operation, unripened fruit is run off the end of the sorting table into lugs, and also sorted into lugs. These lugs of loose fruit, stacked in unit loads by members of the sorting crew, are transported to a ripening room and set down there. Some days later, these unit loads are returned to the sorting table and again run through the sorting cycle, or, if ripe enough to pack, transported to the packing line. The labor required for transporting from the working area to ripening rooms is the same as for moving fruit from ripening rooms to the working area for the three types of handling equipment.

Other less important in-plant handlings are: (1) Transporting unit loads of empty lugs to and from the lug storage area, and (2) transporting empty wirebound crates from the sorting table to the shipping platform. Empty lugs are moved from storage to the sorting table as needed, and lugs emptied and stacked in unit loads at the packing line are returned to storage. Empty wirebound crates are stacked on the handling equipment or on the floor by the dumper. The unit loads are then picked up, transported to the loading platform, and set down on it.

Fruit packed in tray master containers and in place-pack cartons is transported to a holding area. This is either a ripening room or an area near the shipping platform. The worker closing tray master containers or place-pack cartons at the packing line stacks the containers in unit loads on the handling equipment (fig. 26). A transporter moves the unit loads of packed fruit from the packing line to the holding area.

TABLE 21.—*Number of specified containers and weight per unit load for 3 handling methods*

Containers	2-wheel clamp truck		36- by 48-inch dead skid and low-lift platform truck		48- by 40-inch pallet and electric pallet transporter	
	Containers	Weight	Containers	Weight	Containers	Weight
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
60-pound wirebound crates	5	300	20	1, 200	30	1, 800
20-pound lugs of loose tomatoes	10	200	32	640	42	840
10-tray master containers	22	190	115	1, 000	115	1, 000
20-pound place-pack cartons	10	200	50	1, 000	50	1, 000
Empty wirebound crates	14	----------	36	----------	36	----------
Empty lugs	20	----------	64	----------	80	----------

BN-17244

FIGURE 26.—Worker building unit loads on a dead skid (left) and a clamp truck (right).

Loading Out

When a customer's order is to be filled, containers of packed fruit are removed from the holding area, transported to a delivery truck and stowed in it. The elements of work in this operation are: (1) Setup, (2) transport, (3) stow containers in truck, and (4) cleanup. Setup includes opening truck doors, getting and positioning a bridgeplate, and obtaining handling equipment. The unit loads are transported to the truck and set down on the truckbed. The packed containers are then stowed in the truck by one or two workers. After the last container is stowed in the truck, the handling equipment and bridgeplate are returned to their storage locations.

In this study, loading-out crews were selected to minimize labor requirements for the three types of handling equipment. Two workers were selected for the two-wheel clamp-truck system; one worker transported unit loads from the holding area to the delivery truck, while the other worker stowed containers in the truck. Three workers were selected for both the dead skid and platform truck system and the pallet and electric transporter system; one worker transported, while two workers stowed containers in the delivery truck.

Cost of Handling Operations

Labor and equipment costs are presented for only one method for each type of equipment. This method is the one that results in the lowest handling cost when that equipment is used.

The electric pallet transporter handling equipment achieved the lowest cost per 1,000 pounds, of the three handling systems studied (table 22). Of the total cost of 78.5 cents to perform the three handling operations, 58.8 cents was for labor and 19.7 cents for equipment. Unit loads can be picked up, transported, and set down at a faster rate by electric pallet transporter than by dead skid and low-lift platform truck. The elapsed time per 1,000 pounds required to move a unit load from the ripening room to the working area was 54 percent less for the electric pallet transporter than for the low-lift platform truck.

Labor cost to perform all handling operations when the dead skid and platform truck system was used amounted to 96.2 cents. This is about 50 percent greater than labor cost for the electric transporter and pallet method. The cost of handling small unit loads is reflected in the high labor costs associated with the two-wheel clamp-truck system.

Total cost for the two-wheel clamp-truck method was 141.6 cents per 1,000 pounds. This was 2¼ times larger than for the electric transporter and pallet method, and about 40 percent higher than that for dead skids and low-lift platform trucks.

Assembling Shipping Containers

Tomato repackers use two types of shipping containers that must be assembled, a one-piece container with hinge-type cover, and a two-piece container. The one-piece container is used by many repackers as a master shipping container for trays, while the two-piece container is used more for place-packing 10 or 20 pounds of fruit.

Following are the steps, or elements, of the assembling operation for the one-piece container: (1) Transport bundle of flat containers from storage and place on table, (2) assemble container on top of pile by folding in two corners at a time and locking with appropriate tabs, (3) rotate container and repeat procedure for the other two corners, and (4) place assembled container on floor or in chute leading to packing area.

The procedure for assembling the two-piece container is as follows:

(1) Transport bundle of flat containers from storage to stitching machine, (2) pick up flat container (top or bottom half), (3) fold in corner, place in stitching machine and insert two staples, (4) repeat for other three corners, (5) place assembled half of container on floor or in chute, and (6) repeat steps 2 through 5 for second half of container.

Assembling containers is a one-man operation, and a "fill-in" job in most tomato repacking plants. A worker not needed for tray-packing or sorting operations is shifted to assembling containers, or five or six workers assemble containers during slack periods.

Direct labor and equipment costs for assembling 100 one- and two-piece containers are shown in

TABLE 22.—*Combined labor and equipment costs to receive 1,000 pounds of tomatoes into ripening rooms, transport full and empty containers within plant, and load out packed fruit, for 3 equipment types, annual volume received 3,000,000 pounds (one-way transport distance for each operation, 100 feet)* [1]

Operations	Quantity handled	2-wheel clamp truck						Dead skids and platform truck		
		Crew	Elapsed time	Labor required [1]	Cost			Crew	Elapsed time	Labor required [1]
					Labor [2]	Equipment [3]	Total			
Receiving:										
60-pound wirebound crates to ripening room	*Pounds* 1000	*Number* 3	*Hours* 0. 0360	*Man-hours* 0. 108	*Cents* 21. 6	*Cents* 0. 1	*Cents* 21. 7	*Number* 2	*Hours* 0. 0436	*Man-hours* 0. 087
Transporting within plant:										
60-pound wirebound crates from ripening room to sorting table	1000	1	. 0580	. 058	11. 6	. 1	11. 7	1	. 0300	. 030
20-pound lugs from working area to ripening room	[4] 1250	1	. 1100	. 110	22. 0	. 2	22. 2	1	. 0788	. 079
20-pound lugs from ripening room to working area	[4] 1250	1	. 1100	. 110	22. 0	. 2	22. 2	1	. 0788	. 079
Packed containers from packing line to holding area	810	1	. 0713	. 071	14. 2	. 1	14. 3	1	. 0340	. 034
Empty lugs:										
From storage to working area	[5] 44	1	. 0387	. 039	7. 8	. 1	7. 9	1	. 0299	. 030
From working area to storage	[5] 44	1	. 0387	. 039	7. 8	. 1	7. 9	1	. 0299	. 030
Empty crates:										
From sorting table to shipping platform	[6] 17	1	. 0211	. 021	4. 2	. 1	4. 3	1	. 0170	. 017
Total					89. 6	. 9	90. 5			
Loading out:										
Packed containers from holding area to, and stowed in, delivery truck	820	2	. 0729	. 146	29. 2	. 2	29. 4	3	. 0317	. 095
Grand total					140. 4	1. 2	141. 6			

Operations	Dead skids and platform truck			Pallets and electric transporter					
	Cost			Crew	Elapsed time	Labor required [1]	Cost		
	Labor [2]	Equipment [3]	Total				Labor [2]	Equipment [3]	Total
Receiving:									
60-pound wirebound crates to ripening room	*Cents* 17. 4	*Cents* 0. 5	*Cents* 17. 9	*Number* 2	*Hours* 0. 0384	*Man-hours* 0. 077	*Cents* 15. 4	*Cents* 3. 7	*Cents* 19. 1
Transporting within plant:									
60-pound wirebound crates from ripening room to sorting table	6. 0	. 3	6. 3	1	. 0110	. 011	2. 2	1. 1	3. 3
20-pound lugs from working area to ripening room	15. 8	. 9	16. 7	1	. 0362	. 036	7. 2	3. 5	10. 7
20-pound lugs from ripening room to working area	15. 8	. 9	16. 7	1	. 0362	. 036	7. 2	3. 5	10. 7
Packed containers from packing line to holding area	6. 8	. 4	7. 2	1	. 0202	. 020	4. 0	1. 9	5. 9
Empty lugs:									
From storage to working area	6. 0	. 4	6. 4	1	. 0139	. 014	2. 8	1. 3	4. 1
From working area to storage	6. 0	. 4	6. 4	1	. 0139	. 014	2. 8	1. 3	4. 1
Empty crates:									
From sorting table to shipping platform	3. 4	. 2	3. 6	1	. 0090	. 009	1. 8	. 9	2. 7
Total	59. 8	3. 5	63. 3				28. 0	13. 5	41. 5
Loading out:									
Packed containers from holding area to, and stowed in, delivery truck	19. 0	. 4	19. 4	3	. 0257	. 077	15. 4	2. 5	17. 9
Grand total	96. 2	4. 4	100. 6				58. 8	19. 7	78. 5

[1] Tables 41–50, appendix.
[2] At $2.00 per hour.
[3] From table 53, appendix.
[4] Fruit sorted out and transported to, and returned from, ripening rooms, 820 pounds from first sorting and 430 pounds from second sorting.
[5] Empty lugs for 880 pounds of tomatoes, 810 pounds of packageable fruit, and 70 pounds of culls.
[6] Empty wirebound crates per 1,000 pounds of tomatoes.

TABLE 23.—*Labor and equipment costs for 1 worker to assemble 100 tomato shipping containers of 2 types*

Item	Labor required	Cost		
		Labor [1]	Equipment	Total
	Man-hours	*Dollars*	*Dollars*	*Dollars*
1-piece container with hinge cover	0. 370	0. 74		0. 74
2-piece container	. 540	1. 08	[2] 0. 14	1. 22

[1] At $2.00 per hour.
[2] Wire stitching machine at $0.25 per hour of use; cost of wire not included.

table 23. Because of geographical variations, costs of original containers and wire for stapling were not included in the analyses.

Bruise Damage to Tomatoes

Bruise damage is a major cost item of repacking tomatoes. About 18 percent of the tomatoes received by a terminal market repacker usually are sorted out as culls and rejects because of bruising, decay, and defects.

Packing methods and equipment therefore should be designed to minimize bruising injury, by (1) holding down handlings to the minimum necessary, (2) minimizing the distance that tomatoes drop when dumped or run off belts into bins or lugs, (3) providing a soft lining in bins or other containers into which the fruit drops (it was observed that some packers used pads of covered foam rubber), and (4) avoiding high stacking of overfilled containers.

The internal structure of a tomato is subject to bruising at all stages of marketing, whether the tomato is green or ripe. As would be expected, it is especially susceptible to damage after it starts to ripen. Careful handling therefore is essential at all stages of marketing to avoid heavy losses from bruising.

Repacking System Composed of the Most Efficient Methods Studied

From the separate analyses made of sorting, packing, and handling, a tomato repacking system comprising the most efficient methods and equipment was constructed. Labor and equipment requirements were developed for plants of four different sizes, with annual volumes of tomatoes received at 1½, 3, 5, and 10 million pounds.

Labor and equipment requirements were computed on the basis of daily receipts during an operating season of thirty 40-hour weeks. Daily receipts for the four annual volumes are 10,000, 20,000, 33,500, and 67,000 pounds.

In this system, sorting is done at a four-lane roller table with two runoff belts. Fruit is dumped in the two outside lanes, and green fruit is run off from these lanes. Pink and ripe fruit is sorted into one of the inner lanes, and breakers and turns into the other. Culls and rejects are sorted onto the two runoff belts.

Tray-packing and the final sorting are done at a single-lane roller table and a belt sorting table with divided packing bins. Culls and rejects are sorted out at the roller table. At the belt table, the fruit is sorted into the packing bins by color, tray sizes, and place-pack size. Tray-size fruit is sorted also into small and large fruit for the ends and centers of trays. Trays are filled by the partial-fill method.

Place-pack tomatoes are packed loose in 20-pound, two-layer cartons. All handling is done with pallets and an electric pallet transporter.

Based on accepted tomato repacking practices and research findings, the assumptions used to compute labor and equipment requirements for the four daily volumes were:

(1) That fruit would be subjected to two sortings.
(2) That 82 percent of the fruit received would be packed and 18 percent sorted out as culls and rejects.
(3) That 50 percent of the fruit packed out would be tray-packed as 4's, 35 percent as 3's, and 15 percent place-packed in cartons.
(4) That all trays would be packed in 1-piece, 10-tray master containers, and large fruits place-packed loose, in 20-pound, 2-layer cartons.
(5) That all fruit would be received into ripening rooms.
(6) That all intraplant handling of fruit would be in unit loads.
(7) That packed fruit would be moved from the packing line to a holding area, then to a delivery truck to be loaded.

Equipment Requirements

Table 24 shows the units of equipment that would be needed for each of the four daily volumes. Only one four-lane roller sorting table would be needed, assuming the use of two sorters and a table speed of 30 feet per minute for daily volumes of 10,000 and 20,000 pounds; and four

sorters and a table speed of 36 feet per minute for the two larger volumes. The same number of units of packing equipment could be used for daily volumes of 10,000, 20,000, and 30,000 pounds; separate bins, tray setup machines, and overwrap machines would be needed for packing two sizes of tray fruit. Two separate packing systems would be needed for a daily volume of 67,000 pounds, because the elapsed time for one line would exceed 8 hours. Two electric pallet transporters would be needed to perform handling operations connected with the two packing lines, and to perform receiving and loading operations. Pallet requirements would range from 125 for the 10,000-pound volume to 800 for the 67,000-pound volume.

Labor Requirements

Daily Volume of 10,000 Pounds

Using the efficient tomato repacking system described, a crew of nine workers would be needed for repacking a daily volume of 10,000 pounds (table 25).

Workers 1 through 5 would sort tomatoes on the four-lane roller table for a total of 3.12 hours. The five-man sorting crew also would make preparations for the day's work (setup) and clean up the equipment and floors in the working area at the end of the day. At the packing line, workers 1 through 8 would sort for quality, color, and size for a total of 2.01 hours; workers 1, 2, and 3 would sort out rejects and culls on the single-lane roller table, while workers 4, 5, 6, 7, and 8 would inspect and sort for size and color on the sorting belt. After filling the bins with packageable fruit, workers 1 through 8 would shift to packing 3's (0.84 hour) or, with the help of the ninth worker, 4's (1.05 hours). The sort-pack cycle would be repeated until all tray-size fruit was packed. Worker No. 9 would assemble tray master containers and place-pack cartons while workers 1 through 8 sorted and inspected packageable fruit and tray-packed 3's. While workers 1 through 5 sorted fruit on the four-lane roller table, workers 6, 7, and 8 would place-pack large tomatoes (0.65 hour), accumulated in bins while sorting for tray-size fruit, and load out packed fruit (0.32 hour). Workers 7 and 8 would also receive fruit into ripening rooms (0.32 hour). Handling operations, other than receiving and loading, would be performed alternately by workers 6, 7, and 8. This crew would be productively employed for 57.07 man-hours of the total time available of 72.00 man-hours. The difference between total labor available and total productive time of 14.93 man-hours would be adequate for crew members to change job assignments and for two 15-minute rest periods, one in the morning and one in the afternoon.

Daily Volume of 20,000 Pounds

A 16-man crew, productively used for 114.48 man-hours, could perform all operations required to repack a daily volume of 20,000 pounds (table 26). Workers 1 through 5 would sort on the four-lane roller table for 6.24 hours and set up for the

TABLE 24.—*Units of equipment required for tomato repacking plants handling specified annual volumes of tomatoes*

Equipment	Units of equipment for annual volumes of—			
	1½ million pounds	3 million pounds	5 million pounds	10 million pounds
	Number	*Number*	*Number*	*Number*
Sorting:				
4-lane roller table	1	1	1	1
Packing:				
3- by 10-foot single-lane roller table	1	1	1	2
2- by 60-foot sorting belt	1	1	1	2
Detachable shelf for place-packing	4	6	6	8
Overwrap machine	2	2	2	4
Single bin with 3 dividers	3	3	3	6
Tray belt, 6 inches by 30 feet	2	2	2	4
Tray setup machine	2	2	2	4
Handling:				
Bridgeplate	2	2	3	3
Conveyor:				
Wheel, 10-foot section	4	4	6	8
90° curved section	1	1	1	2
Floor support	6	6	10	12
Electric pallet transporter	1	1	1	2
Pallet, 48- by 40-inch	125	250	400	800
Other:				
Scales, 125-lb. capacity	1	1	1	2
Stitching machine	1	1	2	2

TABLE 25.—*Daily labor required by a 9-man crew to receive 10,000 pounds of tomatoes and repack them, by use of selected types of equipment* [1]

Operation	Workers	Volume handled	Elapsed time	Labor required
	Nos.	*1,000 pounds*	*Hours*	*Man-hours*
Productive labor:				
Setup and cleanup	1–5	----	0. 17	0. 85
Sorting—4-lane roller table:				
First sorting	1–5	10. 0	1. 77	8. 85
Second sorting	1–5	6. 0	1. 35	6. 75
Packing—pack from divided bins using partial tray-filling method:				
Sort on roller and belt tables	1–8	8. 2	2. 01	16. 08
4's	1–9	4. 1	1. 05	9. 45
3's	1–8	2. 9	. 84	6. 72
Place-pack, loose, 20-lb. cartons	6–8	1. 2	. 65	1. 95
Assembling containers:				
10-tray master containers	9	[2] 8	2. 96	2. 96
20-lb. place-pack cartons	9	[2] 1	. 54	. 54
Handling—with pallets and electric transporter:				
Receive:				
To ripening room	7–8	10. 0	. 32	. 64
From ripening room to sorting table	6–8	10. 0	----	. 11
Transport between ripening rooms and work area	6–8	12. 5	----	. 90
Load out:				
To holding area	6–8	8. 2	----	. 17
Holding area to delivery truck	6–8	8. 2	----	. 96
Transport empty lugs to and from storage	6–8	[3] 1. 0	----	. 10
Transport empty shipping containers to platform	6–8	[4] 2	----	. 04
Total productive labor	----	----	----	57. 07
Unproductive labor:				
Personal allowance [5]	9	----	. 50	4. 50
Changing jobs [6]	9	----	1. 16	10. 43
Total unproductive labor	----	----	----	14. 93
Total labor	9	----	----	72. 00

[1] Total labor requirements were determined from productive time required to perform all operations.
[2] 100 containers.
[3] 100 empty lugs.
[4] 100 empty wirebound crates.
[5] Two 15-minute rest periods.
[6] Time allowed for workers to change from one job to another.

day's operation and clean up the working area at the end of the workday (0.32 hour); these five workers, and workers 14, 15, and 16, would also sort for quality, size, and color at the packing line for 0.52 hour. Workers 6 through 13 would be assigned full-time to packing operations; they would sort for quality, size, and color on the single-lane roller table and sorting belt for 3.50 hours, tray-pack 3's for 1.68 hours, and with the assistance of worker 14, tray-pack 4's for 2.12 hours. Between work assignments at the packing line, and for the remainder of the workday (4.50 hours), worker 14 would assemble containers. Workers 15 and 16, for the remainder of the workday (6.50 hours), would divide their time between packing large tomatoes in 20-pound cartons (1.95 hours), loading out packed fruit (1 hour), receiving (0.77 hour); and while worker 15 assembled containers, worker 16 would perform in-plant handling operations with an electric pallet transporter (2.64 hours). Of the daily total of 128 man-hours, 5.52 man-hours would be available for changing jobs, and 8 man-hours for two 15-minute rest periods.

Daily Volume of 33,500 Pounds

A minimum of 25 workers would be required to receive, sort, pack, and handle daily receipts of 33,500 pounds of tomatoes by this repacking system (table 27). Workers 1 through 10 would initially sort 33,500 pounds of fruit on the four-lane roller table for 2.01 hours. Workers 1 through 5 would re-sort tomatoes for 4.52 hours and also perform setup and cleanup operations in the working area (0.55 hour); these five workers, assisted by workers 23, 24, and 25, would pack some size 3 tomatoes (0.40 hour). Workers 15 through 22 would sort at the packing line for quality, color, and size for 6.75 hours, and tray-pack 3's for 0.61 hour. Workers 6 through 14 would tray-pack 4's for 3.56 hours and, while workers 6 through 13 tray-packed 3's for 1.80 hours, worker 14 would pack large tomatoes in 20-pound cartons. Workers 11 and 12 would place-pack tomatoes in cartons and workers 13 and 14 would assemble containers (2 hours) during the time workers 1 through 10 were initially sorting fruit on the four-lane roller table. In addition to tray-packing 3's, workers 23, 24, and 25 would load out packed fruit (1.07

TABLE 26.—*Daily labor required by a 16-man crew to receive 20,000 pounds of tomatoes and repack them, by use of selected types of equipment* [1]

Operation	Workers	Volume handled	Elapsed time	Labor required
		1,000 pounds		
Productive labor:	*Nos.*		*Hours*	*Man-hours*
Setup and cleanup	1–5		0. 32	1. 60
Sorting—4-lane roller tables:				
First sorting	1–5	20. 0	3. 54	17. 70
Second sorting	1–5	12. 0	2. 70	13. 50
Packing—pack from divided bins using partial tray-filling method:				
Sort on roller and belt tables	[2]	16. 4		32. 16
4's	6–14	8. 2	2. 12	19. 08
3's	6–13	5. 8	1. 68	13. 44
Place-pack, loose, 20-lb. cartons	15–16	2. 4	1. 95	3. 90
Assemble containers:				
10-tray master containers	[3]	[4] 1. 6		7. 00
20-lb. place-pack cartons	[3]	[4]. 2		
Handling—with pallets and electric transporter:				
Receive:				
To ripening room	15–16	20. 0	. 77	1. 54
From ripening room to sorting table	16	20. 0	. 22	. 22
Transport between ripening rooms and work area	16	25. 0	1. 80	1. 80
Load out:				
To holding area	16	16. 4	. 34	. 34
Holding area to delivery truck	15–16	16. 4	. 96	1. 92
Transport empty lugs to and from storage	16	[5] 2. 0	. 20	. 20
Transport empty shipping containers to platform	16	[6]. 3	. 08	. 08
Total productive labor				114. 48
Unproductive labor:				
Personal allowances [7]	16		. 50	8. 00
Changing jobs [8]	16		. 34	5. 52
Total unproductive labor				13. 52
Total labor	16			128. 00

[1] Total labor requirements were determined from productive time required to perform all operations.
[2] Workers 6 through 13 for 3.50 hours, and workers 1 through 5, and 14, 15, and 16 for 0.52 hour; total labor, 32.16 man-hours.
[3] Worker 14 for 4.50 hours and worker 15 for 2.50 hours; total labor, 7.00 man-hours.
[4] 100 containers.
[5] 100 empty lugs.
[6] 100 empty wirebound crates.
[7] Two 15-minute rest periods.
[8] Time allowed for workers to change from one job to another.

hours). While workers 23 and 24 place-packed large fruit and assembled containers, worker 25 would perform in-plant handling operations with an electric pallet transporter (4.43 hours). The receiving of 33,500 pounds of fruit into ripening rooms would require 1.29 hours of productive time of workers 24 and 25. Of the 200 man-hours available for performing all operations, 5.07 man-hours would be available for changing from one job to another and 12.50 man-hours for morning and afternoon rest periods of 15 minutes each.

Daily Volume of 67,000 Pounds

More definite work assignments are possible for repacking large daily volumes of tomatoes. This makes scheduling of work easier for management, and labor more productive because less time is required for changing jobs.

Using the most efficient methods and equipment studied, a 48-man crew could perform all operations connected with repacking a daily volume of 67,000 pounds of tomatoes. As shown in table 28, workers 1 through 10 would initially sort 67,000 pounds of tomatoes in 4.02 hours, and resort 40,200 pounds in 3.32 hours. Workers 11 through 26 would sort for quality, size, and color at two separate packing systems for 6.76 hours, and for 0.66 hour would place-pack fruit in 20-pound cartons. Workers 27 through 35, by shifting from one packing system to the other, would tray-pack 4's for 7.13 hours; they would also pack fruit in 20-pound cartons for about 0.25 hour. Workers 36 through 43 would tray-pack 3's for 5.62 hours, and assemble tray master containers and place-pack cartons for 1.73 hours. Worker 44 would transport unit loads of full and empty containers within the plant for 6.30 hours, and assist workers 45, 46, and 47 with setup and clean-up operations in the working area. Workers 45, 46, and 47 would also load out packed fruit for 2.14 hours, assemble containers for 0.69 hour, and, while worker 47 performed handling operations with one of the two electric pallet transporters, workers 45 and 46 would receive 67,000 pounds of tomatoes into ripening rooms (2.56 hours). Worker 48 would assemble tray master containers and place-pack cartons for the 7½-hour work

TABLE 27.—*Daily labor required by a 25-man crew to receive 33,500 pounds of tomatoes and repack them, by use of selected types of equipment* [1]

Operation	Workers	Volume handled	Elapsed time	Labor required
	Nos.	*1,000 pounds*	*Hours*	*Man-hours*
Productive labor:				
Setup and cleanup	1–5		0. 55	2. 75
Sorting—4-lane roller table:				
First sorting	1–10	33. 5	2. 01	20. 10
Second sorting	1–5	20. 1	4. 52	22. 60
Packing—pack from divided bins, using partial tray-filling method:				
Sort on roller and belt tables	15–22	27. 5	6. 75	54. 00
4's	6–14	13. 8	3. 56	32. 04
3's	[2]	9. 7		22. 48
Place-pack, loose, 20-lb. cartons	[3]	4. 0		6. 50
Assemble containers:				
10-tray master containers	[4]	[5] 2. 7		11. 74
20-lb. place-pack cartons	[4]	[5] . 3		
Handling—with pallets and electric transporter:				
Receive:				
To ripening room	24–25	33. 5	1. 29	2. 58
From ripening room to sorting table	25	33. 5	. 37	. 37
Transport between ripening rooms and work area	25	41. 9	3. 02	3. 02
Load out:				
To holding area	25	27. 5	. 57	. 57
Holding area to delivery truck	23–25	27. 5	1. 07	3. 21
Transport empty lugs to and from storage	25	[6] 3. 4	. 34	. 34
Transport empty shipping containers to platform	25	[7] . 6	. 13	. 13
Total productive labor				182. 43
Unproductive labor:				
Personal allowance [8]	25		. 50	12. 50
Changing jobs [9]	25		. 20	5. 07
Total unproductive labor				17. 57
Total labor	25			200. 00

[1] Total labor requirements were determined from productive time required to perform all operations.
[2] Workers 6 through 13 for 1.80 hours, workers 15 through 22 for 0.61 hour, and workers 1 through 5 and 23, 24, and 25 for 0.40 hour; total labor, 22.48 man-hours.
[3] Worker 13 for 1.94 hours, workers 11 and 12 for 1.68 hours, and workers 23 and 24 for 0.60 hour; total labor, 6.50 man-hours.
[4] Workers 23 and 24 for 3.86 hours, and workers 13 and 14 for 2.01 hours; total labor, 11.74 man-hours.
[5] 100 containers.
[6] 100 empty lugs.
[7] 100 empty wirebound crates.
[8] Two 15-minute rest periods.
[9] Time allowed for workers to change from one job to another.

period. Of the 384.00 man-hours available, 352.95 man-hours would be productive, 24 man-hours would be used for morning and afternoon rest periods, and 7.05 man-hours would be available for changing jobs.

Labor and Equipment Costs

Sorting, packing, and handling costs per 1,000 pounds are affected by the volume of tomatoes repacked. This holds true not only for the system based on the most efficient methods and equipment studied, but also for other repacking systems. With changes in volume, both total and unit costs for performing each operation change. Estimated costs for labor and equipment used directly to repack tomatoes by the efficient system developed in this study ranged from $11.59 per 1,000 pounds for a daily volume of 67,000 pounds to $14.80 for a daily volume of 10,000 pounds (table 29). Costs for materials (trays, containers, overwrap material, etc.), management, and space are not included.

As the total volume of fruit handled increases, equipment costs per 1,000 pounds are reduced. Equipment costs of $3.37 per 1,000 pounds at the daily volume of 10,000 pounds are over three times those for the 67,000-pound volume. A large part of these costs, representing depreciation, taxes, and interest, are fixed. Except for some equipment of minor importance, the same equipment can be used to handle daily receipts of 10,000, 20,000, and 33,500 pounds. Thus, the larger the volume over which the fixed costs can be spread, the lower the cost per unit.

TABLE 28.—*Daily labor required by a 48-man crew to receive 67,000 pounds of tomatoes and repack them, by use of selected types of equipment* [1]

Operation	Workers	Volume handled	Elapsed time	Labor required
	Nos.	*1,000 pounds*	*Hours*	*Man-hours*
Productive labor:				
Setup and cleanup	44–47		1. 38	5. 52
Sorting—4-lane roller tables:				
First sorting	1–10	67. 0	4. 02	40. 20
Second sorting	1–10	40. 2	3. 32	33. 20
Packing—pack from divided bins using partial tray-filling method:				
Sort on roller and belt tables	11–26	55. 0	6. 75	108. 00
4's	27–35	27. 6	7. 13	64. 17
3's	36–43	19. 4	5. 62	44. 96
Place-pack, loose, 20-lb. cartons	[2]	8. 0		13. 09
Assemble containers:				
10-tray master containers	[3]	[4] 5. 4		23. 41
20-lb. place-pack cartons	[3]	[4] . 6		
Handling—with pallets and electric transporter:				
Receive:				
To ripening room	45–46	67. 0	2. 56	5. 12
From ripening room to sorting table	[5]	67. 0	. 74	. 74
Transport between ripening rooms and work area	[5]	83. 8	6. 04	6. 04
Load out:				
To holding area	[5]	55. 0	1. 14	1. 14
Holding area to delivery truck	45–47	55. 0	2. 14	6. 42
Transport empty lugs to and from storage	[5]	[6] 6. 8	. 68	. 68
Transport empty shipping containers to platform	[5]	[7] 1. 2	. 26	. 26
Total productive labor				352. 95
Unproductive labor:				
Personal allowance [8]	48		. 50	24. 00
Changing jobs [9]	48		. 15	7. 05
Total unproductive labor				31. 05
Total labor	48			384. 00

[1] Total labor requirements were determined from productive time required to perform all operations.
[2] Workers 11 through 26 for 0.66 hour, and workers 27 through 35 for 0.27 hour; total labor, 13.09 man-hours.
[3] Worker 48 for 7.50 hours, workers 36 through 43 for 1.73 hours, and workers 45, 46, and 47 for 0.69 hour; total labor, 23.41 man-hours.
[4] 100 containers.
[5] Worker 44 for 6.30 hours and worker 47 for 2.56 hours; total labor 8.86 man-hours.
[6] 100 empty lugs.
[7] 100 empty wirebound crates.
[8] Two 15-minute rest periods.
[9] Time allowed for workers to change from one job to another.

TABLE 29.—*Comparative labor and equipment costs per 1,000 pounds of tomatoes received, for sorting, packing, and handling specified daily volumes, by selected types of equipment*

Operations by indicated volume	Crew size [1]	Labor required [2]	Costs		
			Labor [3]	Equipment [4]	Total
10,000 pounds daily:	*Number*	*Man-hours*	*Dollars*	*Dollars*	*Dollars*
Sorting	5	1. 56	3. 12	0. 35	3. 47
Packing	9	3. 42	6. 84	2. 42	9. 26
Assembling containers	1	. 35	. 70	. 06	. 76
Handling [5]	3	. 38	. 76	. 55	1. 31
Total	9	5. 71	11. 42	3. 37	14. 80
20,000 pounds daily:					
Sorting	5	1. 56	3. 12	. 19	3. 31
Packing	9	3. 42	6. 84	1. 24	8. 08
Assembling containers	1	. 33	. 70	. 03	. 73
Handling [5]	3	. 38	. 76	. 34	1. 10
Total	16	5. 71	11. 42	1. 79	13. 22
33,500 pounds daily:					
Sorting	10	1. 27	2. 54	. 12	2. 66
Packing	17	3. 43	6. 86	. 76	7. 62
Assembling containers	2	. 35	. 70	. 03	. 73
Handling [5]	3	. 39	. 78	. 26	1. 04
Total	25	5. 44	10. 88	1. 17	12. 05
67,000 pounds daily:					
Sorting	10	1. 10	2. 20	. 06	2. 26
Packing	33	3. 44	6. 88	. 71	7. 59
Assembling containers	8	. 35	. 70	. 02	. 72
Handling [5]	3	. 39	. 78	. 24	1. 02
Total	48	5. 28	10. 56	1. 03	11. 59

[1] Number of workers used to perform each operation and total number of workers. Crews would not be assigned full-time to any one operation.
[2] Productive labor.
[3] At $2.00 per hour.
[4] Equipment ownership and operation costs are shown in tables 57 through 60, appendix.
[5] Includes setup and cleanup in sorting and packing areas.

Appendix

Research Methods and Techniques

Data and information were obtained in plants receiving and ripening mature green tomatoes and packaging them for ultimate consumption fresh. Each step of each operation was observed and time-studied from the time the tomatoes were received to the loading of packed containers into delivery trucks.

Two techniques were used to obtain elemental time data for all operations. These were: (1) Time study, using a decimal-minute stopwatch, and (2) rated work sampling. Time study was used for those operations where input-output data were obtainable for individual workers. Using the stopwatch method, the observer recorded the time required for a worker to perform each element of work. Rated work sampling was used to study operations where crew interrelationships existed and input-output data were obtainable for two or more people working as a team, such as those sorting and filling trays. By use of rated work sampling, observations were made at random intervals of each individual member of a team of workers. A record was made for each observation of elements which were being performed. The labor requirements were computed for each element from these observations.

Delays were classified and recorded as either avoidable or unavoidable. Avoidable delays are controlled by the workers. Delays such as those from a breakdown of the tray setup machine or overwrap machine, or a lack of fruit on the sorting table were classified as unavoidable. The labor requirements established for each operation do not include any provision for either type of delay.

While recording data, whether by time study or rated work sampling, the observer estimated the effort level of the worker being studied. This was expressed as a percentage. The basis for comparison was a normal performance level of 100 percent. This is a measure of the effort that an experienced worker is expected to put forth in the normal execution of his assigned duties. In observing a given worker, the observer compared the worker's effort with a normal performance. He then recorded a percent which was higher, lower, or equal to the normal rate. The observed time was multiplied by the percent effort level to convert it to the time that would be required if the worker studied had performed at a normal pace. This time value is defined as the base time.

The elemental time values used in the report are productive times; they provide a sound basis for comparison of crew sizes, methods, and equipment. The productive time is equal to the base time plus an allowance for fatigue. The fatigue allowance provides time for the worker to rest so as to overcome the fatigue resulting from sustained physical effort. The percent value used for the fatigue allowance is directly related to physical effort and the working conditions connected with an assigned job.

The productive time usually includes an allowance of 5 percent for personal needs of employees. However, since most terminal market tomato repackers provide two rest periods of 10 to 15 minutes per 8-hour day, which is sufficient to cover personal needs of the workers, no personal allowance is provided in the productive times.

Labor Costs

For valid cost comparisons of methods studied the same wage rate was used to compute all labor costs. The majority of terminal market tomato packagers employ both men and women. The women perform the sorting and tray-filling functions, while men perform heavier manual tasks, such as receiving, loading out, dumping at the sorting line, transporting, and stacking. The wage rate was assumed to be $2.00 per hour for both male and female workers. This rate includes the basic wage paid plus payments for social security, workers' compensation insurance, hospitalization, and other fringe benefits. Earnings of supervisory personnel are not included in labor cost computations.

Fatigue Allowances

The following fatigue allowances are applicable for performing specified sorting, tray-packing, place- or cup-packing, and handling operations in terminal-market tomato-packing plants.

Time item	*Fatigue allowance, percent*
Fill and close master container	5
Inspect filled trays	5
Place trays in setup machine	5
Set up trays by hand	5
Transport with electric-powered transporter	5
Break out empty nested lugs	10

Time item	Rating allowance, percent
Catch runoff at end of sorting table	10
Close and set aside empty 60-lb. wirebound crates	10
Dump 20- to 60-lb. containers	10
Fill trays	10
Insert roll of film in overwrap machine	10
Manually transport carton of 1,000 trays and open cartons	10
Manually transport packed cartons	10
Manually transport precut master containers, set up and transport assembled containers	10
Manually transport 20-lb. containers	10
Nest and set aside 4 empty lugs	10
Open 60-lb. wirebound crates	10
Place packed master containers in load	10
Place-pack tomatoes in container, weigh, close, and place in load	10
Sort tomatoes for color, size, and quality	10
Transport with 2-wheel clamp truck	10
Transport with dead skid and jack lift	10
Manually build unit loads of 60-lb. wirebound crates	15
Manually transport 60-lb. wirebound crates	15
Manually handle empty pallets and skids	20

Productive Labor Data

Setup and Cleanup

Tray-packing.—Setup and cleanup in packing trays of tomatoes begins when a worker turns on lights in the tray-packing area. The work includes assembling transportation equipment, bringing up empty garbage cans and steel drums, supplies of trays and master containers, uncovering overwrap machine, placing lugs of tomatoes in racks at packing stations; filling the tray setup machine, and starting it and the tray belt conveyor and overwrap machine; also walking to the storage closet, getting brooms, shovels, and rags, picking up loose tomatoes and paper on the floor and placing them in steel drums, collecting empty lugs and placing them in storage, sweeping the floor in work area, wiping off equipment with rags, emptying garbage cans into steel drums and transporting the drums to the garbage pickup point, covering the overwrap machine, and returning brooms and shovels to the storage closet. It ends when a worker turns off lights in the tray-packing area.

For tray-packing 1,000 pounds of tomatoes, the base time for setup and cleanup is 0.0652 man-hour; fatigue allowance, 0.0065 man-hour; and productive time, 0.0717 man-hour.

Sorting.—Setup and cleanup in sorting tomatoes begins when a worker turns on lights in the sorting area. The work includes assembling transportation equipment, bringing up empty lugs, garbage cans, and steel drums, opening the ripening room door, turning on water for the washer, and starting the sorting table; also includes walking to a storage closet, getting brooms, shovels, rags, and hose, turning off the water to the washer, picking up loose tomatoes on the floor, collecting empty lugs and placing them in storage, sweeping the floor in the work area, hosing down the floor and sorting-table surface, wiping water off the sorting-table surface, emptying garbage cans into steel drums and transporting the drums to the garbage pickup point, and returning brooms, shovels, and hose to the storage closet. It ends when a worker turns off the lights in the sorting area.

In sorting 1,000 pounds, the base time is 0.0218 man-hour; the fatigue allowance, 0.0022 man-hour; and the productive time, 0.0240 man-hour.

Place-packing.—Setup and cleanup in place-packing tomatoes begins when a worker turns on the lights in the place- or cup-pack area. Work includes assembling transportation equipment, bringing up empty garbage cans and steel drums, bringing up supplies of cups or paper wrappers and cartons, checking the scales for correct weight, and placing lugs of tomatoes in the rack at packing stations, or in packing bins; also walking to a storage closet, getting brooms and shovels, picking up loose tomatoes and paper on the floor and placing them in steel drums, collecting empty place-pack cartons and empty lugs and placing them in storage, sweeping the floor in the work area, emptying garbage cans into steel drums and transporting the drums to the garbage pickup point, and returning brooms and shovels to the storage closet. It ends when a worker turns off lights in the place-pack area.

In place-packing 1,000 pounds, the base time is 0.0150 man-hour; the fatigue allowance, 0.0015 man-hour; and the productive time, 0.0165 man-hour.

Unloading from carrier.—Setup and cleanup in unloading tomatoes from a carrier begins when an order is received to start unloading. Work includes assembling the crew and transportation equipment, opening the railroad car or highway truck doors, placing a bridgeplate, removing wood bracing and stripping, installing a weatherguard, and placing an extension light in the car or truck; also removing the extension light, weatherguard, and bridgeplate and placing them in temporary storage, closing the railroad car or highway truck and ripening room doors, turning off the lights, and recording data on the shipment. It ends when workers return the transportation equipment to storage.

In unloading 1,000 pounds of tomatoes from a carrier, the base time is 0.0030 man-hour; fatigue allowance, 0.0003 man-hour; and productive time, 0.0033 man-hour.

Loading delivery trucks.—Setup and cleanup in loading delivery trucks begins when an order is received to start loading a delivery truck. Work includes assembling a crew and transportation equipment, and getting and positioning a bridgeplate; also removing and placing the bridgeplate in temporary storage, and returning transportation equipment. It ends when the transportation equipment is released in the storage area.

In loading 1,000 pounds into a delivery truck, the base time is 0.0025 man-hour; fatigue allowance, 0.0002 man-hour; and productive time, 0.0027 man-hour.

Sorting Operations

The work directly connected with sorting tomatoes for color, culls, and rejects was divided into four work elements. These elements are defined as:

(1) *Inspect on table:* Begins when sorter starts scanning fruit on table. Includes visually inspecting, and rolling or turning tomatoes on table to permit more thorough inspection. Ends when sorter starts to grasp tomato.

(2) *Inspect in hand:* Begins when sorter grasps tomato. Includes grasping, picking up, turning, and closely inspecting tomato in hand. Ends when sorter starts to place tomato in container, in bin, or on runoff belt, or return it to table.

(3) *Place in container, in bin, or on runoff belt:* Begins when sorter starts to place tomato in container, in bin, or on runoff belt. Includes transporting tomato to container, bin, or runoff belt, and releasing it there. Ends when sorter releases tomato.

(4) *Other:* (a) *Get empty container:* Begins when sorter starts toward containers. Includes reaching, grasping, picking up container on roller conveyor or in stack, and placing it in position at sorting table. Ends when sorter releases container. (b) *Set aside full container:* Begins when sorter starts to reach for container. Includes reaching for, sliding to position, or picking up container and placing atop another full container. Ends when sorter releases container.

Packing Operations

Elemental data for two partial tray-fill methods were obtained by use of rated work sampling. The elements were defined as follows:

(1) *Pick up and inspect:* Begins when packer starts to reach for tomato. Includes reaching, grasping, picking up one or two tomatoes, and turning and closely inspecting each tomato. Ends when packer starts to place tomato in tray, in lug, or on runoff belt.

(2) *Place in tray:* Begins when packer starts to place tomato in tray. Includes placing tomato in tray and adjusting for best fit. Ends when packer releases tomato.

TABLE 30.—*Comparative labor requirements for sorting 1,000 pounds of tomatoes, using specified types of equipment*

Equipment and time item	Translation speed per minute	First sorting [1]				Second sorting [2]			
		Sorters	Base time	Fatigue allowance	Productive time	Sorters	Base time	Fatigue allowance	Productive time
	Feet	*Number*	*Man-hours*	*Man-hours*	*Man-hours*	*Number*	*Man-hours*	*Man-hours*	*Man-hours*
Belt tables:									
Belt and lugs	35	5				6			
Inspect on table			0. 1874	0. 0187	0. 2061		0. 2763	0. 0276	0. 3039
Pick up and inspect in hand			. 2991	. 0299	. 3290		. 3971	. 0397	. 4368
Place in container			. 1498	. 0150	. 1648		. 2245	. 0224	. 2469
Other			. 0341	. 0034	. 0375		. 0614	. 0061	. 0675
Belt and packing bins	32	4				3			
Inspect on table			. 1622	. 0162	. 1784		. 1376	. 0138	. 1514
Pick up and inspect in hand			. 2291	. 0229	. 2520		. 2893	. 0289	. 3182
Place in bin or container			. 1605	. 0160	. 1765		. 1650	. 0165	. 1815
Other			. 0017	. 0002	. 0019		. 0170	. 0017	. 0187
Roller tables:									
Three lanes	30	5				5			
Inspect on table			. 1385	. 0138	. 1523		. 1866	. 0187	. 2053
Pick up and inspect in hand			. 2148	. 0215	. 2363		. 2885	. 0288	. 3173
Place in lane or container			. 1269	. 0127	. 1396		. 1704	. 0170	. 1874
Three lanes and packing bins	16	4				3			
Inspect on table			. 1886	. 0189	. 2075		. 2679	. 0268	. 2947
Pick up and inspect in hand			. 3466	. 0347	. 3813		. 2341	. 0234	. 2575
Place in lane or container			. 2282	. 0228	. 2510		. 1745	. 0174	. 1919
Four lanes	30	2				2			
Inspect on table			. 0807	. 0081	. 0888		. 0769	. 0077	. 0846
Pick up and inspect in hand			. 1445	. 0145	. 1590		. 1948	. 0195	. 2143
Place in lane or on runoff belt			. 0965	. 0096	. 1061		. 1375	. 0138	. 1513
Four lanes	36	4				4			
Inspect on table			. 0463	. 0046	. 0509		. 0571	. 0057	. 0628
Pick up and inspect in hand			. 0831	. 0083	. 0914		. 1084	. 0108	. 1192
Place in lane or on runoff belt			. 0799	. 0080	. 0879		. 1118	. 0112	. 1230

[1] Fruit consisted of 60 percent greens, 12 percent breakers, 10 percent turns, 8 percent pinks, 5 percent ripes, 2 percent culls, and 3 percent rejects.
[2] Fruit consisted of 30 percent greens, 25 percent breakers, 17 percent turns, 10 percent pinks, 10 percent ripes, 5 percent culls, and 3 percent rejects.

TABLE 31.—*Comparative labor requirements per occurrence for elements connected with sorting tomatoes*

Element description	Workers	Base labor	Fatique allowance	Productive labor
Dump container: Begins when worker starts to grasp container in stack. Includes grasping, picking up, transporting 5 feet, and setting container down on dump ledge, opening container, tilting forward, and emptying container. Ends when empty container is returned to dump ledge.	*Number*	*Man-hours*	*Man-hours*	*Man-hours*
20-lb. lug	1	0. 0012	0. 0001	0. 0013
60-lb. wirebound crate	1	. 0052	. 0005	. 0057
Set aside empty container: Begins when worker starts to pick up container on dump ledge. Includes picking up, transporting 5 feet, setting container down in unit load or in stack, and returning to dump station. Ends when worker starts to grasp another full container.				
20-lb. lug [1]	1	. 0006	. 0001	. 0007
20-lb. lug	1	. 0018	. 0002	. 0020
60-lb. wirebound crate	1	. 0014	. 0001	. 0015
Break out empty lugs: [2] Begins when worker starts toward stack of lugs. Includes walking to stack, grasping, picking up, transporting 10 feet, setting lug down at work station or on roller conveyor, and pushing forward. Ends when lug is released	1	. 0015	. 0002	. 0017
Transport lug of loose tomatoes: [2] Begins when worker starts toward 20-pound lug of loose tomatoes. Includes walking to lug, grasping, picking up, transporting 10 feet, and setting lug down in stack or load. Ends when lug is released	1	. 0021	. 0002	. 0023
Fill lug: Begins when worker starts to grasp empty lug on 6-inch belt conveyor or on roller conveyor. Includes grasping and placing lug under runoff chute, stepping on pedal to open chute gate, filling and leveling about 20 pounds tomatoes in lug, releasing pedal, pushing lug forward on roller conveyor. Ends when lug is released	1	----------	----------	[3]

[1] Empty lug is placed on 6-inch belt conveyor above dumper, instead of in stack or unit load.
[2] Also used for elements connected with packing.
[3] Because runoff chutes must be attended when performing the sorting operation, the time value for this element is equal to the elapsed time for sorting.

TABLE 32.—*Comparative labor requirements for packing 1,000 pounds of tomatoes in trays by 2 partial-fill methods*

Type of equipment and time element	Four tomatoes per tray			Three tomatoes per tray		
	Base time	Fatigue allowance	Productive time	Base time	Fatigue allowance	Productive time
Pack from lugs: [1]						
6 packers:	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
Pick up and inspect	1. 3711	0. 1371	1. 5082	----------	----------	----------
Place in tray	1. 3913	. 1391	1. 5304	----------	----------	----------
Place culls, rejects, etc. in container or on runoff belt	. 1591	. 0159	. 1750	----------	----------	----------
Inspect and repack filled trays	. 3758	. 0376	. 4134	----------	----------	----------
Other	[2] . 0880	. 0088	. 0968	----------	----------	----------
Pack from bins: [3]						
5 packers:						
Pick up and inspect	. 9226	. 0923	1. 0149	0. 9531	0. 0953	1. 0484
Place in tray	. 9146	. 0915	1. 0061	. 7102	. 0710	. 7812
Place culls, rejects, etc. in container or on runoff belt	. 0990	. 0099	. 1089	. 1130	. 0113	. 1243
Inspect and repack filled trays	. 0808	. 0081	. 0889	. 0527	. 0053	. 0580
Other	----------	----------	----------	----------	----------	----------

[1] Eighty percent of fruit moved to line was packed in trays and 20 percent sorted out by packers as rejects, seconds, other sizes, etc.
[2] Consists of: Set aside empty containers, 0.0321 man-hour; and get full containers, 0.0293 man-hour.
[3] Ninety-three percent of fruit placed in bins was packed in trays.

(3) *Place nonpackageable fruit in lug or on runoff belt:* Begins when packer starts to place tomato in lug or on runoff belt. Includes transporting to, and releasing, tomato in lug or on runoff belt. Ends when tomato is released.

(4) *Inspect and repack filled trays:* Begins when packer starts to scan filled trays. Includes visually inspecting filled trays for best fit and defective fruit, and rearranging or replacing fruit in trays for best fit and matching color. Ends when packer releases tomatoes in tray.

(5) *Other:* (a) *Get full lug:* Begins when packer starts to reach for lug. Includes reaching, grasping, and placing lug in position on inclined rack. Ends when lug is released. (b) *Set aside empty lug:* Begins when packer starts to reach for lug. Includes reaching, grasping, lifting, and placing lug on roller conveyor or in stack. Ends when lug is released.

Productive labor requirements for these two methods of tray-packing are given in table 32; the data for the other four methods of tray-packing are given in table 33.

TABLE 33.—*Comparative labor requirements for packing 1,000 pounds of tomatoes in trays, by 2 filling methods*

Element description	Worker	Base labor	Fatigue allowance	Productive labor
Complete-fill method:				
Pack from lugs: Begins when packer starts to reach for empty tray. Includes grasping and sliding empty tray from tray belt to narrow ledge beside belt, reaching, grasping, picking up tomato in each hand, inspecting, placing and positioning in ends of tray, reaching, picking up, and inspecting 1 or 2 other tomatoes and placing and positioning in center of tray, and sliding filled tray onto belt conveyor. Ends when filled tray is released.	*Number*	*Man-hours*	*Man-hours*	*Man-hours*
3 tomatoes per tray	1	2. 5813	0. 2581	2. 8394
4 tomatoes per tray	1	3. 2755	. 3276	3. 6031
Pack from bins:				
Method A: Begins when packer starts to reach for empty tray. Includes grasping, picking up, and placing empty tray on 15- by 25-inch packing board, picking up tomato in bin with right hand, inspecting, transferring to left hand, and placing in tray, repeating until tray is filled, and returning filled tray to tray belt leading to overwrap machine. Ends when filled tray is released.				
3 tomatoes per tray	1	2. 0952	. 2095	2. 3047
4 tomatoes per tray	1	2. 1714	. 2171	2. 3885
Method B: Begins when packer starts to reach for tomato. Includes reaching, grasping, picking up tomato in right hand, inspecting, and placing in tray held in left hand, repeating until tray is filled, and placing filled tray on belt conveyor leading to overwrap machine. Ends when tray is released.				
3 tomatoes per tray	1	2. 9333	. 2933	3. 2266
4 tomatoes per tray	1	3. 7333	. 3733	4. 1066
Partial-fill method:				
Pack from bin: Begins when packer starts to reach for tomatoes. Includes reaching, grasping, picking up one tomato in each hand, and simultaneously placing tomatoes in alternate trays on belt conveyor. Ends when tomatoes are released.				
3 tomatoes per tray [1]	4	1. 0286	. 1029	1. 1315
4 tomatoes per tray [2]	5	1. 1428	. 1143	1. 2571

[1] Four tray-packers were used to pack 3-to-a-tray fruit. The 2 packers nearest the tray setup machine placed end tomatoes in all trays, last 2 packers placed center tomatoes in all trays.

[2] Five tray-packers were used to pack 4-to-a-tray fruit. The 2 packers nearest the tray setup machine placed end tomatoes in all trays and last 3 packers placed 2 middle tomatoes in the trays.

TABLE 34.—*Comparative labor requirements for sorting 1,250 pounds of ripe tomatoes at the tray-packing line, using specified types of equipment*

Equipment	Sorters	Base time	Fatigue allowance	Productive time
	Number	*Man-hours*	*Man-hours*	*Man-hours*
One-lane roller table	2	[1] 0. 4377	0. 0438	0. 4815
Two-lane roller table	2	[2] . 8083	. 0808	. 8891
Three-lane roller table	3	[3] . 8433	. 0843	. 9276
Sorting belt and divided packing bins	5	[4] 1. 1164	. 1116	1. 2280
Sorting belt and bins	2	[5] . 8500	. 0850	. 9350

[1] Ten percent sorted out because of poor quality, and 90 percent run off at end of table.
[2] Thirteen percent sorted out because of poor quality, color, and size, and 87 percent run off at end of table.
[3] Twenty percent sorted out because of poor quality, color, and size, and 80 percent run off at end of table.
[4] For sorting 1,125 pounds run off one-lane roller table. Eleven percent run off belt because of color and 89 percent sorted into divided bins.
[5] Twenty percent sorted out because of poor quality, color, and size, and 80 percent sorted into packing bins.

TABLE 35.—*Comparative labor requirements per occurrence for elements connected with packing tomatoes in trays*

Element description	Workers	Base labor	Fatigue allowance	Productive labor
	Number	*Man-hours*	*Man-hours*	*Man-hours*
Transport and open carton of 1,000 trays: [1]				
Begins when worker starts toward storage area. Includes walking 30 feet to storage area, grasping, picking up, transporting, setting down, and opening carton. Ends when carton is released	1	0. 0090	0. 0009	0. 0099
Place 1,000 trays in setup machine: [1]				
Begins when worker starts toward opened carton of trays. Includes walking to carton, picking up 50–75 trays, transporting 5 feet, and placing in setup machine. Ends when trays are released	1	. 1300	. 0130	. 1430
Set up 1,000 trays by hand: [1]				
Begins when tray-packer starts toward opened carton of trays. Includes walking to carton, picking up 50 trays, transporting 10 feet, setting down in packing bin, and setting up by folding in ends of trays. Ends when last tray is set up	1	. 6167	. 0617	. 6784
Fill and close tray master container: [1]				
Begins when worker starts to reach for empty container. Includes reaching and getting container from stack beside work station, setting down and positioning on table, filling, closing, sliding closed container to edge of table, and placing container in unit load. Ends when container is released.				
One-piece, 10-tray container	1	. 0032	. 0003	. 0035
Two-piece, 10-tray container	1	. 0049	. 0005	. 0054
Assemble containers:				
Begins when worker starts toward storage area. Includes transporting 2 bundles of knocked-down containers 10 feet from storage to work station, assembling containers by folding in or stapling corners, and stacking on floor or placing on chute to packing area. Ends when assembled container is released.				
One-piece container	1	. 0034	. 0003	. 0037
Two-piece container	1	. 0049	. 0005	. 0054
Insert roll of film in overwrap machine:				
Begins when worker starts toward roll of film near overwrap machine. Includes walking to roll of film, picking up, and removing metal cups in ends of core, inserting 3-foot metal rod through core, carrying rod and roll of film to overwrap machine, positioning on rack, and feeding film into machine. Ends when worker starts overwrap machine	1	. 0217	. 0022	. 0239

[1] 14-ounce trays.

TABLE 36.—*Comparative labor requirements per occurrence for elements connected with place-packing tomatoes*

Element description	Workers	Base time	Fatigue allowance	Productive time
Place-pack loose, in cups or in paper wrappers: Begins when packer grasps empty container. Includes getting container from stack, setting down and positioning on packing stand, packing layer of tomatoes loose, in cups, or in paper wrappers, and, for 2-layer packs, inserting cardboard divider and packing second layer, picking up packed container, transporting, setting down on roller conveyor, and pushing forward to weigher. Ends when packer starts to grasp empty container.	*Number*	*Man-hours*	*Man-hours*	*Man-hours*
Ten pounds, 2 layers, loose pack	1	0. 0142	0. 0014	0. 0156
Ten pounds, single layer, packed in cups	1	. 0205	. 0020	. 0225
Ten pounds, 2 layers, packed in paper wrappers	1	. 0235	. 0024	. 0259
Twenty pounds, 2 layers, loose pack	1	. 0258	. 0026	. 0284
Twenty pounds, 2 layers, first layer loose pack, second layer packed in cups	1	. 0277	. 0028	. 0305
Twenty-eight pounds, wood lug, packed in paper wrappers	1	. 0802	. 0080	. 0882
Weigh, close, and place packed container in unit load: Begins when worker starts toward packed container on stand or roller conveyor. Includes grasping, sliding, or rolling container onto scale, checking for correct weight, making necessary adjustments in weight, getting and placing or nailing cover on container, picking up container, transporting 6 feet, setting down in unit load, and returning to roller conveyor or scale. Ends when worker starts to grasp next container.				
Carton	1	. 0037	. 0004	. 0041
Lug	1	. 0090	. 0009	. 0099

Handling Operations

Following are element descriptions of handling operations used in the report:

Position skid or pallet for loading: Begins when worker starts toward empty pallet or skid. Includes walking to empty skid or pallet, lifting, transporting an average distance of 24 feet, and placing in position for loading. Ends when pallet or skid has been released.

Remove empty pallet or skid: Begins when worker starts toward empty pallet or skid. Includes walking to empty pallet or skid, lifting, transporting an average distance of 24 feet, and placing in supply stack. Ends when pallet or skid has been released.

Load in carrier: Begins when worker starts toward workface. Includes walking to workface, grasping container, lifting and securing container, carrying to handtruck, pallet, or dead skid, positioning and releasing in load, and returning for next container. Ends when last container is released in position in load.

Enter carrier: Begins when empty handling equipment contacts bridgeplate. Includes crossing bridgeplate and transporting empty equipment into carrier. Ends when worker releases equipment or equipment touches skid or pallet.

Pick up load: Begins when handling equipment starts to pass face of load. Includes positioning equipment for pickup, lifting load, and moving load clear of original position. Ends when load clears original position.

Leave carrier: Begins when load clears original position. Includes transporting load to bridgeplate and crossing it. Ends when load clears bridgeplate.

Set down load: Begins when worker starts to position handling equipment for releasing load. Includes positioning load, releasing, and withdrawing equipment. Ends when equipment clears face of load.

Transport loaded and return empty: Begins when load clears bridgeplate at carrier or original position in storage area or ripening room. Includes transporting load to or from storage area or ripening room and returning empty. Ends when equipment contacts bridgeplate or next load in storage area or ripening room.

Handstack containers from 2-wheel clamp truck, pallet, or skid into delivery truck: Begins when worker starts toward loaded 2-wheel clamp truck, pallet, or skid. Includes walking to load, grasping container, lifting and securing container, carrying to workface in truck, positioning and releasing in stack. Ends when last container is released in delivery truck.

TABLE 37.—*Comparative labor requirements per occurrence for one man, for tomato handling elements, for specified types of equipment* [1]

Element and type of equipment	Base time	Fatigue allowance	Productive time
	Man-hours	*Man-hours*	*Man-hours*
Position pallet or skid for loading [2]	0. 0052	0. 0010	0. 0062
Enter carrier:			
Two-wheel clamp truck	. 0008	. 0001	. 0009
Dead skid and low-lift platform truck	. 0028	. 0003	. 0031
Pallet and electric pallet transporter	. 0023	. 0001	. 0024
Pick up load:			
Two-wheel clamp truck	. 0021	. 0002	. 0023
Dead skid and low-lift platform truck	. 0064	. 0006	. 0070
Pallet and electric pallet transporter	. 0018	. 0001	. 0019
Leave carrier:			
Two-wheel clamp truck	. 0019	. 0002	. 0021
Dead skid and low-lift platform truck	. 0030	. 0003	. 0033
Pallet and electric pallet transporter	. 0032	. 0002	. 0034
Set down load:			
Two-wheel clamp truck	. 0011	. 0001	. 0012
Dead skid and low-lift platform truck	. 0086	. 0009	. 0095
Pallet and electric pallet transporter	. 0026	. 0001	. 0027
Remove pallet or skid [2]	. 0062	. 0012	. 0074

[1] Except where noted, elemental base times were computed from data given in the appendix of MRR No. 478, Receiving Fruits and Vegetables in Wholesale Warehouses, U.S. Dept. Agr., October 1961.

[2] Computed from elemental base times given in appendix of MRR No. 476, Apple Handling and Packing in the Appalachian Area, U.S. Dept. Agr., June 1961.

TABLE 38.—*Comparative labor requirements per 1,000 pounds of tomatoes, for 1- and 2-man crews to load containers on equipment in carrier* [1]

Crew and equipment	Weight of container	Base time	Fatigue allowance	Productive time
	Pounds	*Man-hours*	*Man-hours*	*Man-hours*
One man:				
Two-wheel clamp truck	30	0. 0325	0. 0032	0. 0357
	40	. 0300	. 0045	. 0345
	50	. 0275	. 0041	. 0316
	60	. 0250	. 0038	. 0288
Dead skid or pallet	30	. 0380	. 0038	. 0418
	40	. 0360	. 0054	. 0414
	50	. 0340	. 0051	. 0391
	60	. 0320	. 0048	. 0368
Two men:				
Two-wheel clamp truck	30	. 0415	. 0042	. 0457
	40	. 0375	. 0056	. 0431
	50	. 0335	. 0050	. 0385
	60	. 0296	. 0044	. 0340
Dead skid or pallet	30	. 0555	. 0056	. 0611
	40	. 0525	. 0079	. 0604
	50	. 0500	. 0075	. 0575
	60	. 0472	. 0071	. 0543

[1] Computed from elemental base times given in appendix of MRR No. 478, Receiving Fruit and Vegetables in Wholesale Warehouses, U.S. Dept. Agr., October 1961.

TABLE 39.—*Comparative labor requirements per 1,000 pounds of tomatoes for 1- and 2-man crews to hand-stack containers, from 2-wheel clamp truck, dead skid, or pallet into delivery truck* [1]

Crew and container	Base time	Fatigue allowance	Productive time
One man:	*Man-hours*	*Man-hours*	*Man-hours*
10-pound container	0. 0535	0. 0054	0. 0589
20-pound container	. 0500	. 0050	. 0550
30-pound container	. 0470	. 0047	. 0517
40-pound container	. 0440	. 0044	. 0484
50-pound container	. 0410	. 0041	. 0451
Two men:			
10-pound container	. 0530	. 0053	. 0583
20-pound container	. 0510	. 0051	. 0561
30-pound container	. 0490	. 0049	. 0539
40-pound container	. 0470	. 0047	. 0517
50-pound container	. 0450	. 0045	. 0495

[1] Computed from elemental base times given in appendix of MRR No. 478, Receiving Fruits and Vegetables in Wholesale Warehouses, U.S. Dept. Agr., October 1961.

TABLE 40.—*Comparative labor requirements per trip for one man transporting load of tomatoes within a packing plant, and returning empty, when specified types of handling equipment are used*

Equipment	Distance	Base time	Fatigue allowance	Productive time
	Feet	*Man-hours*	*Man-hours*	*Man-hours*
Two-wheel clamp truck	20	0. 0025	0. 0002	0. 0027
	40	. 0051	. 0005	. 0056
	60	. 0076	. 0008	. 0084
	80	. 0102	. 0010	. 0112
	100	. 0127	. 0013	. 0140
	150	. 0190	. 0019	. 0209
Dead skid and low-lift platform truck	20	. 0063	. 0006	. 0069
	40	. 0092	. 0009	. 0101
	60	. 0121	. 0012	. 0133
	80	. 0150	. 0015	. 0165
	100	. 0179	. 0018	. 0197
	150	. 0252	. 0025	. 0277
Pallet and electric pallet transporter	20	. 0037	. 0002	. 0039
	40	. 0062	. 0003	. 0065
	60	. 0087	. 0004	. 0091
	80	. 0112	. 0006	. 0118
	100	. 0138	. 0007	. 0145
	150	. 0201	. 0010	. 0211

TABLE 41.—*Labor required by 3-man crew to receive 1,000 pounds of tomatoes, using 2-wheel clamp trucks* [1]

Time item	Labor required
Productive labor:	*Man-hours*
Setup and cleanup	0. 0033
Build unit load in carrier [2]	. 0288
Pick up load in carrier	. 0177
Transport 100 feet	. 0467
Set down load in storage	. 0040
Total productive labor	. 1005
Unproductive labor:	
1 man waits while 2 men set up and clean up	. 0016
1 man, building unit loads, waits for 2 transporters	. 0054
Total unproductive labor	. 0070
Total labor	. 1075
	Hours
Elapsed time	. 0358

[1] Crew organization: 2 men set up and clean up, 1 man builds unit loads in carrier, 2 men transport.
[2] Unit load of five 60-pound wirebound crates.

TABLE 42.—*Labor required by 2-man crew to receive 1,000 pounds of tomatoes, using dead skid and low-lift platform truck* [1]

Time item	Labor required
Productive labor:	*Man-hours*
Setup and cleanup	0. 0033
Position skid in carrier	. 0052
Load skid [2]	. 0368
Pick up load in carrier	. 0112
Transport 100 feet	. 0164
Set down load in storage	. 0079
Total productive labor	. 0808
Unproductive labor:	
Transporter waits for man loading skid	. 0065
Total labor	. 0873
	Hours
Elapsed time	. 0436

[1] Crew organization: 2 men set up and clean up, 1 man positions and loads skids in carrier, 1 man transports.
[2] Unit load of twenty 60-pound wirebound crates.

TABLE 43.—*Labor required by 2-man crew to receive 1,000 pounds of tomatoes, using pallets and electric pallet transporter* [1]

Time item	Labor required
Productive labor:	*Man-hours*
Setup and cleanup	0. 0033
Position pallet in carrier	. 0034
Load pallet [2]	. 0368
Pick up load in carrier	. 0043
Transport 100 feet	. 0081
Set down load in storage	. 0015
Total productive labor	. 0574
Unproductive labor:	
Transporter waits for man loading pallets	. 0195
Total labor	. 0769
	Hours
Elapsed time	. 0384

[1] Crew organization: 2 men set up and clean up, 1 man positions and loads pallets in carrier, 1 man transports.
[2] Unit load of thirty 60-pound wirebound crates.

TABLE 44.—*Labor required by 1 worker to move 1,000 pounds of tomatoes in wirebound crates from ripening room to sorting table, by 3 types of handling equipment*

Equipment	Unit load of 60-lb. wirebound crates	Pick up load	Transport 100 feet	Set down load	Total labor
	Number	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
2-wheel clamp truck	5	0. 0077	0. 0467	0. 0040	0. 0584
Dead skid and platform truck	20	. 0058	. 0164	. 0079	. 0301
Electric pallet transporter	30	. 0011	. 0081	. 0015	. 0107

TABLE 45.—*Labor required by 1 worker to move 1,000 pounds of loose tomatoes in lugs from sorting line to ripening room, by 3 types of handling equipment*

Equipment	Unit load of 20-lb. lugs	Position empty pallet or skid	Pick up load	Transport 100 feet	Set down load	Total labor
	Number	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
2-wheel clamp truck	10	----------	0. 0115	0. 0700	0. 0060	0. 0875
Dead skid and platform truck	32	0. 0097	. 0109	. 0308	. 0148	. 0662
Electric pallet transporter	42	. 0074	. 0023	. 0173	. 0032	. 0302

TABLE 46.—*Labor required by 1 worker to move 1,000 pounds of packed tomatoes from packing line to holding area, using 3 types of handling equipment*

Equipment	Unit load	Position empty pallet or skid	Pick up load	Transport 100 feet	Set down load	Total labor
	Number	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
2-wheel clamp truck	[1]	----------	0. 0115	0. 0700	0. 0060	0. 0875
Dead skid and platform truck	[2]	0. 0062	. 0070	. 0197	. 0095	. 0424
Electric pallet transporter	[2]	. 0062	. 0019	. 0145	. 0027	. 0253

[1] Unit loads: Twenty-two 10-tray master containers and ten 20-pound place-pack containers.
[2] Unit loads: One hundred fifteen 10-tray master containers and fifty 20-pound place-pack containers.

TABLE 47.—*Labor required by 1 worker to move empty lugs and wirebound crates 100 feet, using 3 types of handling equipment*

Equipment	Unit load		Position empty pallet or skid	Pick up load	Transport	Set down load	Total labor
	Lugs	Wirebound crates					
	Number	*Number*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
2-wheel clamp truck	20	14	----------	0. 0023	0. 0140	0. 0012	0. 0175
Dead skid and platform truck	64	36	0. 0062	. 0070	. 0197	. 0095	. 0424
Electric pallet transporter	80	36	. 0062	. 0019	. 0145	. 0027	. 0253

TABLE 48.—*Labor required by 2-man crew to load 1,000 pounds of packed tomatoes on a delivery truck, using 2-wheel clamp truck* [1]

Time item	Labor
Productive labor:	*Man-hours*
Setup and cleanup	0. 0027
Pick up load in storage [2]	. 0115
Transport 100 feet	. 0700
Set down load in truck	. 0060
Stow containers in truck	. 0589
Total productive labor	. 1491
Unproductive labor:	
Man loading truck waits for transporter	. 0286
Total	. 1777
	Hours
Elapsed time	. 0888

[1] Crew organization: 2 men set up and clean up, 1 man transports, 1 man stows containers in truck.
[2] Unit loads of twenty-two 10-tray master containers or ten 20-pound place-pack containers.

TABLE 49.—*Labor required by 3-man crew to load 1,000 pounds of packed tomatoes on a delivery truck, using dead skid and low-lift platform truck* [1]

Time item	Labor
Productive labor:	*Man-hours*
Setup and cleanup	0. 0027
Pick up load in storage [2]	. 0070
Transport 100 feet	. 0197
Set down load in truck	. 0095
Stow containers in truck	. 0583
Remove empty skid	. 0074
Total productive labor	. 1046
Unproductive labor:	
1 loader waits while other removes empty skid	. 0074
Transporter waits on 2 truck loaders	. 0004
Total unproductive labor	. 0078
Total	. 1124
	Hours
Elapsed time	. 0375

[1] Crew organization: 3 men set up and clean up, 1 man transports, 2 men, one of whom removes empty skid, stow containers in truck.
[2] Unit loads of one hundred and fifteen 10-tray master containers or fifty 20-pound place-pack containers.

TABLE 50.—*Labor required by 3-man crew to load 1,000 pounds of packed tomatoes on a delivery truck using pallets and electric pallet transporter* [1]

Time item	Labor
Productive labor:	*Man-hours*
Setup and cleanup	0. 0027
Pick up load in storage [2]	. 0019
Transport 100 feet	. 0145
Set down load in truck	. 0027
Stow containers in truck	. 0583
Remove empty pallet	. 0074
Total productive labor	. 0875
Unproductive labor:	
Transporter waits on 2 loaders	. 0027
Total	. 0902
	Hours
Elapsed time	. 0301

[1] Crew organization: 3 men set up and clean up, 1 man transports and removes empty pallet, 2 men stow containers in truck.
[2] Unit loads of one hundred and fifteen 10-tray master containers or fifty 20-pound place-pack containers.

Equipment Requirements and Costs

Initial equipment costs were obtained from manufacturers and equipment dealers. Because of the wide variation in freight charges for delivery, these prices were f.o.b. manufacturers' plants, and were current for the year 1961 (table 51).

Equipment costs were grouped into two categories: (1) Ownership costs, consisting of depreciation, interest, taxes, and insurance; and (2) operational costs, comprising power, maintenance, repairs, inspection, and servicing. Depreciation was figured on the straight-line basis. An interest rate of 5 percent was assumed to cover either the cost of borrowing money to purchase equipment, or income lost when company assets were invested in the equipment. Since insurance rates and local taxes vary widely throughout the country, a representative figure of 4 percent was used to compute this cost. A national average rate for commercial electric power of $0.027 per kilowatt hour, as determined by the Federal Power Commission, was used to compute power cost. Annual maintenance cost data were obtained from employees of participating plants.

TABLE 51.—*Ownership and operation costs per unit for equipment used in repacking tomatoes on terminal markets, annual volume received 3,000,000 pounds*

Equipment	Initial cost	Expected life	Ownership cost			
			Depreciation	Interest at 5%	Insurance and taxes at 4%	Total
	Dollars	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Bridgeplate, steel, 48 by 58 inches	225. 00	10	22. 50	6. 19	9. 00	37. 69
Conveyors:						
Belt:						
6-inch width, 30-foot length	900. 00	15	60. 00	24. 00	36. 00	120. 00
16-inch width:						
20-foot length, portable	900. 00	12	75. 00	24. 38	36. 00	135. 38
30-foot length	925. 00	15	61. 67	24. 67	37. 00	123. 34
Wheel:						
5-foot section	25. 00	15	1. 67	. 67	1. 00	3. 34
10-foot section	50. 00	15	3. 33	1. 33	2. 00	6. 66
90° curved section	60. 00	15	4. 00	1. 60	2. 40	8. 00
Floor support	7. 00	15	. 47	. 19	. 28	. 94
Dead skid (36- by 48-inch)	9. 00	12	. 75	. 24	. 36	1. 35
Detachable shelf for bin place-packing	5. 00	10	. 50	. 20	. 20	. 83
Industrial electric pallet transporter:						
Machine	1, 580. 00	10	158. 00			
Battery, 415-kwh capacity	450. 00	5	90. 00			
Charger	300. 00	10	30. 00			
Total	2, 330. 00		278. 00	65. 20	93. 20	436. 40
Lug racks	250. 00	15	16. 67	6. 66	10. 00	33. 33
Manual low-lift platform truck (4,000-lb. capacity)	330. 00	12	27. 50	8. 94	13. 20	49. 64
Overwrap machine	7, 645. 00	15	509. 67	203. 87	305. 80	1, 019. 34
Packing bins:						
Single bin	275. 00	15	18. 33	7. 33	11. 00	36. 66
Single bin with 3 dividers	300. 00	15	20. 00	8. 00	12. 00	40. 00
Twin bins, plus distributing belts, sweeps, tray belts, and lug racks	3, 356. 00	15	223. 73	89. 49	134. 24	447. 46
Pallets, 48 by 40 inches	3. 00	5	. 60	. 09	. 12	. 81
Portable packing stand	15. 00	10.	1. 50	. 41	. 60	2. 51
Scales, 125-pound	585. 00	15	39. 00	15. 60	23. 40	78. 00
Stitching machine	510. 00	15	34. 00	13. 60	20. 40	68. 00
Tray setup machine	1, 250. 00	15	83. 33	33. 33	50. 00	166. 66
Sorting tables:						
Belt, 24″ x 40′	1, 344. 00	15	89. 60	35. 84	53. 76	179. 20
24″ x 60′	1, 816. 00	15	121. 07	48. 43	72. 64	242. 14
Roller, 1 lane, 18″ x 5′	900. 00	15	60. 00	24. 00	36. 00	120. 00
1 lane, 36″ x 10′	1, 505. 00	15	100. 33	40. 13	60. 20	200. 66
2 lanes, 60″ x 10′	1, 688. 00	15	112. 53	45. 01	67. 52	225. 06
3 lanes, 42″ x 16′, plus 6″ transfer belt	2, 293. 00	15	152. 87	61. 15	91. 72	305. 74
3 lanes, 42″ x 16′, plus 2 runoff belts	2, 808. 00	15	187. 20	74. 88	112. 32	374. 40
4 lanes, 60″ x 16′, plus 2 runoff belts:						
400 hours of use	3, 190. 00	15	212. 67	85. 07	127. 60	425. 34
900 hours of use	3, 190. 00	15	212. 67	85. 07	127. 60	425. 34
Two-wheel clamp truck (1,000-lb. capacity)	90. 00	12	7. 50	2. 44	3. 60	13. 54

TABLE 51.—*Ownership and operation costs per unit for equipment used in repacking tomatoes on terminal markets, annual volume received 3,000,000 pounds*—Continued

Equipment	Operating cost			Total annual cost	Annual use	Cost per hour of use	Cost per 1,000 pounds
	Power	Maintenance	Total				
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Hours*	*Dollars*	*Dollars*
Bridgeplate, steel, 48 by 58 inches	----	6.00	6.00	43.69	200	0.2185	0.0146
Conveyors:							
Belt:							
6-inch width, 30-foot length	4.09	20.00	24.09	144.09	325	.4434	.0480
16-inch width:							
20-foot length, portable	2.52	20.00	22.52	157.90	200	.7895	.0526
30-foot length	2.52	24.00	26.52	149.86	200	.7493	.0500
Wheel:							
5-foot section	----	.50	.50	3.84	200	.0192	.0013
10-foot section	----	.50	.50	7.16	200	.0358	.0024
90° curved section	----	1.00	1.00	9.00	200	.0450	.0030
Floor support	----	.25	.25	1.19	200	.0060	.0004
Dead skid (36- by 48-inch)	----	.50	.50	1.85	[1] 80	[2] .0231	.0006
Detachable shelf for bin place-packing	----	.50	.50	1.33	100	.0133	.0004
Industrial electric pallet transporter:							
Machine	----	----	----	----	----	----	----
Battery, 415-kwh capacity	----	----	----	----	----	----	----
Charger	----	----	----	----	----	----	----
Total	30.21	100.00	130.21	566.61	600	.9444	.1889
Lug racks	----	12.00	12.00	45.33	325	.1395	.0151
Manual low-lift platform truck (4,000-lb. capacity)	----	12.00	12.00	61.64	650	.0948	.0205
Overwrap machine	6.14	90.00	96.14	1,115.48	325	3.4322	.3718
Packing bins:							
Single bin	----	18.00	18.00	54.66	325	.1682	.0182
Single bin with 3 dividers	----	22.00	22.00	62.00	325	.1908	.0207
Twin bins, plus distributing belts, sweeps, tray belts, and lug racks	6.14	54.00	60.14	507.60	325	1.5618	.1692
Pallets, 48 by 40 inches	----	.50	.50	1.31	[1] 80	[2] .0164	.0004
Portable packing stand	----	.75	.75	3.26	100	.0326	.0011
Scales, 125-pound	----	14.00	14.00	92.00	250	.3680	.0307
Stitching machine	2.20	18.00	20.20	88.20	350	.2520	.0294
Tray setup machine	2.05	24.00	26.05	192.71	325	.5930	.0642
Sorting tables:							
Belt, 24″ x 40′	18.87	20.00	38.87	218.07	750	.2908	.0727
24″ x 60′	37.77	70.00	107.77	349.91	1,000	.3499	.1166
Roller, 1 lane, 18″ x 5′	9.45	24.00	33.45	153.45	750	.2046	.0512
1 lane, 36″ x 10′	6.61	24.00	30.61	231.27	525	.4405	.0771
2 lanes, 60″ x 10′	6.61	34.00	40.61	265.67	525	.5060	.0886
3 lanes, 42″ x 16′, plus 6″ transfer belt	15.12	60.00	75.12	380.86	600	.6348	.1270
3 lanes, 42″ x 16′, plus 2 runoff belts	37.77	70.00	107.77	482.17	1,000	.4822	.1607
4 lanes, 60″ x 16′, plus 2 runoff belts:							
400 hours of use	15.11	80.00	95.11	520.45	400	1.3011	.1735
900 hours of use	34.02	110.00	144.02	569.36	900	.6326	.1898
Two-wheel clamp truck (1,000-lb. capacity)	----	2.00	2.00	15.54	750	.0207	.0052

[1] Number of times used per year. [2] Cost per use.

TABLE 52.—*Equipment requirements and costs for sorting 1,000 pounds of tomatoes by 5 systems, annual volume received 3,000,000 pounds*

System and equipment	Cost per hour of use	Units required	First sorting			Second sorting		
			Elapsed time	Equipment required	Equipment cost	Elapsed time	Equipment required	Equipment costs
	Dollars	*Number*	*Hours*	*Machine-hours*	*Dollars*	*Hours*	*Machine-hours*	*Dollars*
4-lane roller table with 2 runoff belts [1]	1. 3011	1	0. 0600	0. 0600	0. 0781	0. 0825	0. 0825	0. 1073
4-lane roller table with 2 runoff belts [2]	. 6326	1	. 1770	. 1770	. 1120	. 2250	. 2250	. 1423
Belt and packing bins:								
Belt table, 24 inches by 60 feet	. 3499	1	. 1522	. 1522	. 0532	. 2232	. 2232	. 0781
10-foor section of skate wheel conveyor	. 0355	1		. 1522	. 0054		. 2232	. 0079
Conveyor floor support	. 0060	2		. 3044	. 0018		. 4464	. 0027
Total				. 6088	. 0604		. 8928	. 0887
3-lane roller table:								
3-lane roller table	. 6348	1	. 1200	. 1200	. 0762	. 1420	. 1420	. 0901
10-foot section of skate wheel conveyor	. 0355	2		. 2112	. 0075		. 2840	. 0101
Conveyor floor support	. 0060	4		. 4224	. 0025		. 5680	. 0037
Total				. 7536	. 0862		. 9940	. 1036
Belt:								
Belt table, 24 inches by 40 feet	. 2904	1	. 1475	. 1475	. 0428	. 1759	. 1759	. 0511
1-lane roller table, 18 inches by 5 feet	. 2046	1		. 1475	. 0302		. 1759	. 0360
10-foot section of skate wheel conveyor	. 0355	1		. 1475	. 0052		. 1759	. 0062
Conveyor floor support	. 0060	2		. 2950	. 0018		. 3518	. 0021
Total				. 7375	. 0800		. 8795	. 0954
3-lane roller table with packing bins	. 4822	1	. 2100	. 2100	. 1013	. 2480	. 2480	. 1196

[1] Based on roller translation speed of 36 feet per minute and use of 4 sorters.

[2] Based on roller translation speed of 30 feet per minute and use of 2 sorters.

TABLE 53.—*Equipment requirements and costs to receive 1,000 pounds of tomatoes into ripening rooms, transport full and empty containers within plant, and load out packed fruit, annual volume received 3,000,000 pounds* [1]

Operation	2-wheel clamp truck				Dead skids and platform truck		
	Elapsed time	Units	Time	Cost	Elapsed time	Skids	
						Units	Time
	Hours	*Number*	*Machine-hours*	*Cents*	*Hours*	*Number*	*Machine-hours*
Receiving:							
60-pound wirebound crates to ripening room	0. 0360	2	0. 0720	0. 1	0. 0435	1	0. 0435
Transporting within plant:							
60-pound wirebound crates from ripening room to sorting table	. 0580	1	. 0580	. 1	. 0300	1	. 0300
20-pound lugs from working area to ripening room	. 1100	1	. 1100	. 2	. 0788	1	. 0788
20-pound lugs from ripening room to working area	. 1100	1	. 1100	. 2	. 0788	1	. 0788
Packed containers from packing line to holding area	. 0713	1	. 0713	. 1	. 0340	1	. 0340
Empty lugs:							
From storage to working area	. 0387	1	. 0387	. 1	. 0299	1	. 0299
From working area to storage	. 0387	1	. 0387	. 1	. 0299	1	. 0299
Empty wirebound crates from sorting table to shipping platform	. 0211	1	. 0211	. 1	. 0170	1	. 0170
				. 9			
Loading out:							
Packed containers from holding area to, and stowed in, delivery truck	. 0729	1	. 0729	. 2	. 0317	1	. 0317

Operation	Dead skids and platform truck—Continued			Pallets and electric transporter					
	Trucks		Combined cost	Elapsed time	Pallets		Transporter		Combined cost
	Units	Time			Units	Time	Units	Time	
	Number	*Machine-hours*	*Cents*	*Hours*	*Number*	*Machine-hours*	*Number*	*Machine-hours*	*Cents*
Receiving:									
60-pound wirebound crates to ripening room	1	0. 0435	0. 5	0. 0384	1	0. 0384	1	0. 0384	3. 7
Transporting within plant:									
60-pound wirebound crates from ripening room to sorting table	1	. 0300	. 3	. 0110	1	. 0110	1	. 0110	1. 1
20-pound lugs from working area to ripening room	1	. 0788	. 9	. 0362	1	. 0362	1	. 0362	3. 5
20-pound lugs from ripening room to working area	1	. 0788	. 9	. 0362	1	. 0362	1	. 0362	3. 5
Packed containers from packing line to holding area	1	. 0340	. 4	. 0202	1	. 0202	1	. 0202	1. 9
Empty lugs:									
From storage to working area	1	. 0299	. 4	. 0139	1	. 0139	1	. 0139	1. 3
From working area to storage	1	. 0299	. 4	. 0139	1	. 0139	1	. 0139	1. 3
Empty wirebound crates from sorting table to shipping platform	1	. 0170	. 2	. 0090	1	. 0090	1	. 0090	. 9
			3. 5						13. 5
Loading out:									
Packed containers from holding area to, and stowed in, delivery truck	1	. 0317	. 4	. 0257	1	. 0257	1	. 0257	2. 5

[1] Equipment costs are the product of machine-hours times the cost per hour of use as shown in table 51.

TABLE 54.—*Equipment requirements and costs for tray-packing 1,000 pounds of tomatoes, 4 tomatoes per tray, for 3 partial-fill and 3 complete-fill packing methods, annual volume received 3,000,000 pounds*

Method and equipment	Units required	Equipment required [1]	Cost	
			Per hour of use [2]	Total
Partial-fill method				
Single-lane roller sorting table, sorting belt, and divided packing bins:	*Number*	*Machine-hours*	*Dollars*	*Dollars*
Roller table, 36 inches by 10 feet	1	0.2456	0.4405	0.1082
Belt, 24 inches by 60 feet	1	.2456	.3829	.0940
Divided packing bin	1	.2583	.1908	.0493
Tray setup machine	1	.2583	.5930	.1532
Tray belt	1	.2583	.4434	.1145
Overwrap machine	1	.2583	3.4322	.8865
Total		1.5244		1.4057
2-lane roller sorting table and packing bins:				
Roller table, 60 inches by 10 feet	1	.4445	.5060	.2249
Twin packing bins, distributing belts, sweeps, tray belts, and lug racks	1	.4445	1.5618	.6942
Tray setup machine	1	.4858	.5930	.2881
Overwrap machine	1	.4858	3.4322	1.6674
Total		1.8606		2.8746
Lugs:				
Lug racks	1	.6278	.1395	.0876
Tray setup machine	1	.6278	.5930	.3723
Tray belt	1	.6278	.4434	.2784
Overwrap machine	1	.6278	3.4322	2.1547
Total		2.5112		2.8930
Complete-fill method				
Lugs:				
Lug racks	1	.4573	.1395	.0638
Tray setup machine	1	.4573	.5930	.2712
Tray belt	1	.4573	.4434	.2028
Overwrap machine	1	.4573	3.4322	1.5695
Total		1.8292		2.1073
Belt sorting table and packing bins:				
Belt, 24 inches by 60 feet	1	.4675	.3499	.1636
Packing bins	1	.4675	.1682	.0786
Tray setup machine	1	.4342	.5930	.2575
Tray belt	1	.4342	.4434	.1925
Overwrap machine	1	.4342	3.4322	1.4903
Total		2.2376		2.1825
3-lane roller sorting table and packing bins:				
Roller table, 42 inches by 16 feet	1	.3243	.4822	.1564
Twin packing bins, distributing belts, sweeps, tray belts, and lug racks	1	.3243	1.5618	.5065
Overwrap machine	1	.4508	3.4322	1.5472
Total		1.0994		2.2101

[1] Elapsed time. [2] From table 51.

TABLE 55.—*Equipment requirements and costs for tray-packing 1,000 pounds of tomatoes, 3 tomatoes per tray, for 2 partial-fill and 3 complete-fill packing methods, annual volume received 3,000,000 pounds*

Method and equipment	Units required	Equipment required [1]	Cost	
			Per hour of use [2]	Total
Partial-fill method				
Single-lane roller sorting table, sorting belt, and divided packing bins:	*Number*	*Machine-hours*	*Dollars*	*Dollars*
Roller table, 36 inches by 10 feet	1	0.2456	0.4405	0.1082
Belt, 24 inches by 60 feet	1	.2456	.3829	.0940
Divided packing bin	1	.2898	.1908	.0553
Tray setup machine	1	.2898	.5930	.1719
Tray belt	1	.2898	.4434	.1285
Overwrap machine	1	.2898	3.4322	.9947
Total		1.6504		1.5526
2-lane roller sorting table and packing bins:				
Roller table, 60 inches by 10 feet	1	.4445	.5060	.2249
Twin packing bins, distributing belts, sweeps, tray belts, and lug racks	1	.4445	1.5618	.6942
Tray setup machine	1	.4442	.5930	.2634
Overwrap machine	1	.4442	3.4322	1.5246
Total		1.7774		2.7071
Complete-fill method				
Lugs:				
Lug racks	1	.4801	.1395	.0670
Tray setup machine	1	.4801	.5930	.2847
Tray belt	1	.4801	.4434	.2129
Overwrap machine	1	.4801	3.4322	1.6478
Total		1.9204		2.2124
Belt sorting table and packing bins:				
Belt, 24 inches by 60 feet	1	.4675	.3499	.1636
Packing bins	1	.4675	.1682	.0786
Tray setup machine	1	.4201	.5930	.2491
Tray belt	1	.4201	.4434	.1863
Overwrap machine	1	.4201	3.4322	1.4419
Total		2.1953		2.1195
3-lane roller sorting table and packing bins:				
Roller table, 42 inches by 16 feet	1	.3243	.4822	.1564
Twin packing bins, distributing belts, sweeps, tray belts, and lug racks	1	.3243	1.5618	.5065
Overwrap machine	1	.4071	3.4322	1.3972
Total		1.0557		2.0601

[1] Elapsed time. [2] From table 51.

TABLE 56.—*Equipment requirements and costs for place-packing 1,000 pounds of tomatoes, by 3 methods and 3 carton sizes, annual volume received 3,000,000 pounds*

Type of pack and equipment	Cost per hour of use	Units required	Elapsed time	Equipment required [1]	Equipment cost
	Dollars	*Number*	*Hours*	*Machine-hours*	*Dollars*
10-pound carton, loose pack, 2 layers:					
Detachable shelf	0. 0133	3	0. 6567	1. 9701	0. 0262
Wheel conveyor, 10-foot section	. 0355	2		1. 3134	. 0466
Conveyor floor support	. 0060	3		1. 9701	. 0118
Packing bin	. 1682	1		. 6567	. 1105
Scale, 125-pound	. 3680	1		. 6567	. 2417
Total				6. 5670	. 4368
10-pound carton, cup pack, single layer:					
Portable packing stand	. 0326	3	. 8867	2. 6601	. 0867
Wheel conveyor, 10-foot section	. 0355	2		1. 7734	. 0630
Conveyor floor support	. 0060	3		2. 6601	. 0160
Packing bin	. 1682	1		. 8867	. 1491
Scale, 125-pound	. 3680	1		. 8867	. 3263
Total				8. 8670	. 6411
10-pound carton, paper wrap, 2 layers:					
Portable packing stand	. 0326	3	1. 0000	3. 0000	. 0978
Wheel conveyor, 10-foot section	. 0355	2		2. 0000	. 0710
Conveyor floor support	. 0060	3		3. 0000	. 0180
Packing bin	. 1682	1		1. 0000	. 1682
Scale, 125-pound	. 3680	1		1. 0000	. 3680
Total				10. 0000	. 7230
20-pound carton, loose pack, 2 layers:					
Detachable shelf	. 0133	3	. 5417	1. 6251	. 0216
Wheel conveyor, 10-foot section	. 0355	3		1. 6251	. 0577
Conveyor floor support	. 0060	4		2. 1668	. 0130
Packing bin	. 1682	1		. 5417	. 0911
Scale, 125-pound	. 3680	1		. 5417	. 1993
Total				6. 5004	. 3827
20-pound carton, loose and cup pack, 2 layers:					
Portable packing stand	. 0326	3	. 5767	1. 7301	. 0564
Wheel conveyor, 10-foot section	. 0355	3		1. 7301	. 0614
Conveyor floor support	. 0060	4		2. 3068	. 0138
Packing bin	. 1682	1		. 5767	. 0970
Scale, 125-pound	. 3680	1		. 5767	. 2122
Total				6. 9204	. 4408
28-pound lug, paper wrap:					
Portable packing stand	. 0326	3	1. 1673	3. 5019	. 1142
Wheel conveyor, 10-foot section	. 0355	3		3. 5019	. 1243
Conveyor floor support	. 0060	4		4. 6692	. 0200
Lug rack	. 1395	1		1. 1673	. 1628
Scale, 125-pound	. 3680	1		1. 1673	. 4296
Total				14. 0076	. 8589

[1] From table 51.

TABLE 57.—*Ownership and operation costs for tomato sorting, packing, and handling equipment, annual volume received 1,500,000 pounds*

Operation and equipment	Units of equipment	Ownership cost [1]	Operation cost			Total annual cost	Cost per 1,000 pounds
			Power	Maintenance	Total		
Sorting:	*Number*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
4-lane roller table [2]	1	425.34	16.98	90.00	106.98	532.32	0.3549
Packing:							
3- by 10-foot single-lane roller table	1	200.66	3.78	20.00	23.78	224.44	
2- by 60-foot sorting belt	1	242.14	11.34	30.00	41.34	283.48	
Detachable shelf for place-packing	4	3.32		2.00	2.00	5.32	
Overwrap machine	2	2038.68	6.12	160.00	166.12	2204.80	
Single bin with 3 dividers	3	120.00		60.00	60.00	180.00	
Tray belt	2	240.00	4.10	32.00	36.10	276.10	
Tray setup machine	2	333.32	2.05	40.00	42.05	375.37	
Scales, 125 pounds	1	78.00		10.00	10.00	88.00	
Total		3256.12	27.39	354.00	381.39	3637.51	2.4250
Assembling containers:							
Stitching machine	1	68.00	1.11	16.00	17.11	85.11	.0567
Handling:							
Bridgeplate	2	75.38		12.00	12.00	87.38	
Conveyor, wheel:							
10-foot section	4	26.64		2.00	2.00	28.64	
90° curved section	1	8.00		1.00	1.00	9.00	
Floor support	6	5.64		1.50	1.50	7.14	
Electric pallet transporter	1	436.40	15.12	80.00	95.12	531.52	
Pallet, 48- by 40-inch	125	101.25		62.50	62.50	163.75	
Total		653.31	15.12	159.00	174.12	827.43	.5516

[1] From table 51. [2] Roller sorting table operated at 30 feet per minute with 2 sorters.

TABLE 58.—*Ownership and operation costs for tomato sorting, packing, and handling equipment, annual volume received 3,000,000 pounds*

Operation and equipment	Units of equipment	Ownership cost [1]	Operation cost			Total annual cost	Cost per 1,000 pounds
			Power	Maintenance	Total		
Sorting:	*Number*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
4-lane roller table [2]	1	425.34	33.99	110.00	143.99	569.33	0.18
Packing:							
3- by 10-foot, single-lane roller table	1	200.66	7.56	24.00	31.56	232.22	
2- by 60-foot sorting belt	1	242.14	22.65	34.00	56.65	298.79	
Detachable shelf for place-packing	6	4.98		3.00	3.00	7.98	
Overwrap machine	2	2,038.68	12.28	180.00	192.28	2,230.96	
Single bin with 3 dividers	3	120.00		66.00	66.00	186.00	
Tray belt	2	240.00	8.18	40.00	48.18	288.18	
Tray setup machine	2	333.32	4.10	48.00	52.10	385.42	
Scales, 125 pounds	1	78.00		14.00	14.00	92.00	
Total		3,257.78	54.77	409.00	463.77	3,721.55	1.2405
Assembling containers:							
Stitching machine	1	68.00	2.21	18.00	20.21	88.21	.0294
Handling:							
Bridgeplate	2	75.38		12.00	12.00	87.38	
Conveyor, wheel:							
10-foot section	4	26.64		2.00	2.00	28.64	
90° curved section	1	8.00		1.00	1.00	9.00	
Floor support	6	5.64		1.50	1.50	7.14	
Electric pallet transporter	1	436.40	30.21	100.00	130.21	566.61	
Pallet, 48- by 40-inch	250	202.50		125.00	125.00	327.50	
Total		754.56	30.21	241.50	271.71	1,026.27	.3421

[1] From table 51. [2] Roller sorting table operated at 30 feet per minute with 2 sorters.

TABLE 59.—*Ownership and operation costs for tomato sorting, packing, and handling equipment, annual volume received 5,000,000 pounds*

Operation and equipment	Units of equipment	Ownership cost [1]	Operation cost			Total annual cost	Cost per 1,000 pounds
			Power	Maintenance	Total		
	Number	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Sorting: 4-lane roller table [2]	1	425.34	46.06	118.00	164.06	589.40	0.1179
Packing:							
3- by 10-foot single-lane roller table	1	200.66	11.34	30.00	41.34	242.00	
2- by 60-foot sorting belt	1	242.14	34.00	40.00	74.00	316.14	
Detachable shelf for place-packing	6	4.98		3.00	3.00	7.98	
Overwrap machine	2	2,038.68	20.76	200.00	220.76	2,259.44	
Single bin with dividers	3	120.00		72.00	72.00	192.00	
Tray belt	2	240.00	13.85	48.00	61.85	301.85	
Tray setup machine	2	333.32	6.93	60.00	66.93	400.25	
Scales, 125 pounds	1	78.00		20.00	20.00	98.00	
Total		3,257.78	86.88	473.00	559.88	3,817.66	.7635
Assembling containers: Stitching machine	2	136.00	3.78	20.00	23.78	159.78	.0320
Handling: Bridgeplate	3	113.07		16.00	16.00	129.07	
Conveyor, wheel:							
10-foot section	6	39.96		3.00	3.00	42.96	
90° curved section	1	8.00		1.00	1.00	9.00	
Floor support	10	9.40		2.50	2.50	11.90	
Electric pallet transporter	1	436.40	50.36	120.00	170.36	606.76	
Pallet, 48- by 40-inch	400	324.00		200.00	200.00	524.00	
Total		930.83	50.36	342.50	392.86	1,323.69	.2647

[1] From table 51. [2] Roller sorting table operated at 36 feet per minute with 4 sorters.

TABLE 60.—*Ownership and operation costs for tomato sorting, packing, and handling equipment, annual volume received 10,000,000 pounds*

Operation and equipment	Units of equipment	Ownership cost [1]	Operation cost			Total annual cost	Cost per 1,000 pounds
			Power	Maintenance	Total		
	Number	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Sorting:							
4-lane roller table [2]	1	425.34	41.55	120.00	161.55	586.89	0.0587
Packing:							
3- by 10-foot single-lane roller table	2	401.32	22.65	40.00	62.65	463.97	
2- by 60-foot sorting belt	2	484.28	67.96	50.00	117.96	602.24	
Detachable shelf for place-packing	8	6.64		4.00	4.00	10.64	
Overwrap machine	4	4077.36	41.55	160.00	201.55	4278.91	
Single bin with dividers	6	240.00		40.00	40.00	280.00	
Tray belt	4	480.00	27.70	32.00	59.70	539.70	
Tray setup machine	4	666.64	13.85	40.00	53.85	720.49	
Scales, 125 pounds	2	156.00		20.00	20.00	176.00	
Total		6512.24	173.71	386.00	559.71	7071.95	.7072
Assembling containers:							
Stitching machine	2	136.00	7.56	24.00	31.56	167.56	.0168
Handling:							
Bridgeplate	3	113.07		18.00	18.00	131.07	
Conveyor, wheel:							
10-foot section	8	53.28		4.00	4.00	57.28	
90° curved section	2	16.00		2.00	2.00	18.00	
Floor supports	12	11.28		3.00	3.00	14.28	
Electric pallet transporter	2	872.80	100.71	160.00	260.71	1133.51	
Pallet, 48- by 40-inch	800	648.00		400.00	400.00	1048.00	
Total		1714.43	100.71	587.00	687.71	2402.14	.2402

[1] From table 51. [2] Roller sorting table operated at 36 feet per minute with 4 sorters.

U.S. GOVERNMENT PRINTING OFFICE: 1963 O—683-959